

Environmental Fate Assessment for the Synthetic Pyrethroids:

The majority of the synthetic pyrethroids appear to be stable to abiotic transformation, except on alkaline media. The majority of the chemicals undergo hydrolysis to some degree in alkaline (pH 9) media (exceptions are bifenthrin, fenvalerate and tralomethrin, which are stable under such conditions). In alkaline media cyfluthrin, cypermethrin, deltamethrin, and cyhalothrin are highly labile, with half-lives ranging from 2 to 7 days. Fenpropathrin, tefluthrin, and permethrin show moderate stability, with half-lives ranging from 14 to 60 days.

Generally, the synthetic pyrethroids show moderate to low reactivity towards aqueous photolysis. One important exception is tralomethrin, which shows a half-life of only 1 hour. It should be pointed out, however, that the study was conducted in aqueous solution, with a mixture of emulsifiers, to improve the solubility of the chemical. In contrast, the soil photolysis study for this chemical indicated stability of tralomethrin under the testing conditions. For the other synthetic pyrethroids, the aqueous photolytic half-lives range from 5 days to stable. For cyfluthrin ($t_{1/2}$ =4.5 days) and fenvalerate ($t_{1/2}$ =6 days) it appears that aqueous photolysis may be an important route of dissipation.

In general, it appeared that photodegradation on soil is not an important route of degradation for these chemicals. In most cases, the rate of soil photodegradation was of the same order of magnitude as the rate of aerobic metabolism. This appears to indicate that there is a relatively low tendency for the chemical to photolyse when it is bound to soils. One noticeable exception is cyfluthrin, which upon soil photolysis showed a half-life of 5.3 days while in contrast it was relatively stable (half-lives from 74 to 95 days) in the aerobic soil metabolism study.

It appears that aerobic soil metabolism may be an important dissipation mechanism for many of the synthetic pyrethroids. They degrade at moderate rates in various aerobic soils (range 11 days for deltamethrin to 250 days for bifenthrin). In most instances the aerobic and anaerobic soil metabolism half-lives were of similar order of magnitude. Both aerobic and anaerobic degradation yield CO_2 as the major degradate plus various minor components.

All the synthetic pyrethroids are immobile as shown by several analyses, using TLC, soil columns, and adsorption/desorption batch equilibrium. It appears that these chemicals are likely to bind strongly to soil surfaces, therefore, making them less available. This tendency to bind strongly caused that in some cases Freundlich adsorption curves could not be drawn because the concentrations in the solutions were too small. In such cases, single test solutions were reported (e.g. bifenthrin).

The pyrethroids have moderate to low vapor pressure and very low solubilities in water, yielding calculated Henry's Law constants that indicate some potential for volatility. Nevertheless, the high soil/water partitioning indicates a relatively low potential for volatilization.

The terrestrial field dissipation studies for the synthetic pyrethroids show a wide range of half-lives (from 3 days to 228 days). Nevertheless some trends are observed. In general, the half-lives observed in the field are of the same order of magnitude than the ones observed in the laboratory aerobic soil metabolism study. The most stable compound in the laboratory, bifenthrin (aerobic soil metabolism $t_{1/2}$ =129-250 days in three soils tested), was also the most persistent in the field ($t_{1/2}$ =78-228 days in several field studies conducted). However, the aerobic soil metabolism study taken alone could not predict the relative rates of dissipation in the field. In the case of cypermethrin and fenvalerate, which showed low persistence in the field ($t_{1/2}$ <14 days), had moderate persistence under aerobic soil metabolism conditions (60-75 days). Cypermethrin appeared to be susceptible to hydrolysis in alkaline media ($t_{1/2}$ =1.8 days) and fenvalerate was susceptible to aqueous photolysis ($t_{1/2}$ =6 days). Cyfluthrin showed low persistence in various (7) field dissipation studies ($t_{1/2}$ <32 days), despite the fact that it had moderate stability under aerobic soil metabolism conditions ($t_{1/2}$ =4-95 days). The chemical was susceptible, however, to aqueous hydrolysis in alkaline media ($t_{1/2}$ =1.9 days), photolysis in water ($t_{1/2}$ =4.5 days), and soil photodegradation ($t_{1/2}$ =5.3 days). Deltamethrin, fenpropathrin, cyhalothrin, and tefluthrin show moderate stability in the field.

It can also be observed that for the majority of the pyrethroids for which various terrestrial field dissipation studies are available, the persistence is highly variable. This variability is best illustrated for deltamethrin ($t_{1/2}$'s=6-209 days in four studies) and fenpropathrin ($t_{1/2}$'s=8-144 days in five studies). The different half-lives may be due to different environmental conditions, which affect dissipation or degradation mechanisms (such as temperature, light intensity, aerobicity of the soil, rainfall, soil humidity, pH, etc.). Variations of about one order of magnitude can occur in the dissipation of a chemical in the field.

It appears that all the synthetic pyrethroids are strongly adsorbed to soils, precluding the possibility of extensive leaching. It is highly unlikely that they will reach ground waters. The moderate to high persistence of the synthetic pyrethroids indicate that the chemicals are available for runoff for a relatively long period of time (weeks to months postapplication). The low solubility in water, the low mobility observed for all the pyrethroids, and the high soil/water adsorption coefficient observed for most of them indicates that the chemicals would remain adsorbed to the soils and would runoff during rain events causing erosion of the soil.

All the synthetic pyrethroids show high potential to bioaccumulate. Maximum bioconcentration factors ranged from 698X for whole fish (deltamethrin) to 6090X (bifenthrin).

1. HYDROLYSIS

1-1) Bifenthrin: Bifenthrin was reported to be stable to abiotic hydrolysis at 25°C in pH 5, 7, and 9 solutions over the 30 day study duration. EFED agrees with the registrant that the stability of bifenthrin to hydrolysis at all 3 test pHs is somewhat surprising due to the presence of a carboxylate ester linkage in bifenthrin. However, EFED believes that the high percentage of acetonitrile co-solvent (8%) may have interfered with hydrolysis.

1-2) Cyfluthrin: ¹⁴C-phenyl labeled cyfluthrin was reported to be stable to abiotic hydrolysis at 25°C in pH 5 solution over the 35 day study duration. However, its hydrolysis rate increases with increasing pH. EFED computed abiotic half-lives of 185 days ($r^2 = 0.952$, $n = 7$) and 1.9 days ($r^2 = 1.00$, $n = 5$) in pH 7 and 9 solutions, respectively, for the phenyl labeled cyfluthrin.

The major phenyl labeled degradate detected in both the pH 7 and pH 9 solutions was 4-fluoro-3-phenoxybenzaldehyde. In the pH 7 solution, the parent cyfluthrin represented 96% of the applied radioactivity at day 0. The 4-fluoro-3-phenoxybenzaldehyde degradate increased from < 1% on day 0 to 3% (day 7), 6% (day 14), 8% (day 21), 8% (day 28), and 11% (day 35). In the pH 9 solution, the parent cyfluthrin represented 91% of the applied radioactivity at day 0. The 4-fluoro-3-phenoxybenzaldehyde degradate increased from 5% on day 0 to 28% (day 1), 6%(day 14), 64%%(day 3), 86%(day 7), and 89%(days 14 and 21).

EFED believes that the hydrolysis of the carboxylate ester linkage may have also generated 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid (DCVA) in substantial quantities. However, EFED could not confirm that because studies using radiolabeling on the cyclopropane side of the ester linkage were not conducted and cold analyses were not performed on the phenyl labeled studies.

1-3) Cypermethrin: Cypermethrin (a mixture of the cis- and trans-isomers) was reported to be approximately stable to abiotic hydrolysis at 25°C in pH 5 and 7 solutions over the 30 day study duration. However, in pH 9 solutions, EFED computed half-lives of 1.8 days ($r^2 = 0.966$, $n = 7$) and 2.5 days ($r^2 = 0.995$, $n = 7$) for ¹⁴C-cyclopropyl labeled and ¹⁴C-benzyl labeled cypermethrin, respectively.

The major cyclopropyl labeled degradate at pH 9 was a mixture of cis- and trans-3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid referred to hereafter as DCVA. In the pH 9 solution, the parent cyclopropyl labeled cypermethrin accounted for 96.6% of the applied radioactivity at hour 0. DCVA steadily increased from 0% of applied at hour 0 to 23.2% (hour 12), 35.3% (hour 24), 49.8% (hour 36), 55.5% (hour 48), 69.6% (hour 72), and 78.7% (hour 120).

The major benzyl labeled degradate at pH 9 was 3-phenoxybenzaldehyde. In the pH 9 solution, the parent benzyl labeled cypermethrin accounted for 90.4% of the applied radioactivity at hour 0. The degradate 3-phenoxybenzaldehyde steadily increased from 0%

of applied at hour 0 to 13.8% (hour 12), 22.3% (hour 24), 31.0% (hour 36), 39.3% (hour 48), 54.6% (hour 72), and 64.9% (hour 120).

1-4) Deltamethrin: A mixture of ^{14}C -gem(dimethyl) and ^{14}C -benzyl labeled deltamethrin was reported to be stable or approximately stable to abiotic hydrolysis at 25°C in pH 5 and 7 solutions over the 30 day study duration. However, in pH 9 solution, EFED computed an average half-life of 2.5 days. The 2.5 day half-life for deltamethrin in sterile pH 9 solutions is the mean of the half-lives EFED computed for 3 replicate systems: 2.62 days ($r^2 = 0.874$, $n = 10$), 2.71 days ($r^2 = 0.89$, $n = 10$), and 2.28 days ($r^2 = 0.870$, $n = 10$).

At time 0 in the 3 replicate pH 9 solutions, deltamethrin was detected at 9.71 ug/L, 10.9 ug/L, and 10.9 ug/L. The only major hydrolysis degradate in the pH 9 solutions was 3-phenoxybenzaldehyde detected at maximums of 3.24 ug/L (at 2.95 days for replicate A), 3.13 ug/L (at 2.95 days for replicate B), and 3.42 ug/L (at 3.06 days for replicate C).

1-5) Fenpropathrin: [^{14}C]-Fenpropathrin (cyclopropyl and phenyl-ring labeled) was reported to be stable to abiotic hydrolysis at 25°C in pH 5 and 7 solutions over the 30 days study duration. However, its hydrolysis rate in pH 9 solutions was much higher. Registrant-calculated half-lives of 14.3-17.1 days were reported for the pH 9 solutions.

In the pH 9 solution, the major cyclopropyl labeled degradate reported was 2,2,3,3-tetramethylcyclopropanecarboxylic acid, referred to hereafter as TMPA, steadily increased from 0.0% at days 0 to 18.7-22.1% of the applied at day 15 and 39.4-42.8% of the applied on days 21 and 30.

The major benzyl labeled degradate at the pH 9 solution was 3-phenoxybenzoic acid, referred to hereafter as PB-acid. It was 0% on day 0, 25.8-27.7% of the applied on day 10, and reached a maximum at day 30 (last test interval), with 61.2-63.5% of the applied.

Various other minor degradates were also detected in the pH 9 solution. (RS)- α -carbamoyl-3-phenoxybenzyl-2,2,3,3-tetramethyl-cyclopropane carboxylate, referred to hereafter as CONH_2 -fenpropathrin, was $\leq 12.6\%$ of the applied at all test intervals. TMPA-carboxamide increased to 8.8-13.3% of the applied at 15-30 days.

1-6 Fenvalerate: [^{14}C]-Chlorophenyl-labeled-fenvalerate was reported to be stable to abiotic hydrolysis at 25°C in pH 5, 7, and 9 sterile buffered solutions over the 30 day study duration. Significant racemization of ^{14}C -fenvalerate was not observed since the diastereomeric S,S-isomer remained as the major component in the pH 5 and 9 solutions after 30 days.

1-7 Cyhalothrin: [^{14}C -cyclopropane labeled]-lambdacyhalothrin (PP321), at a nominal concentration of 0.1 ppm) was stable to hydrolysis at pH 5.0 and 7.0, but does hydrolyze at pH 9.0 with a reported half-life of 7 days. Hydrolytic degradation and isomerization

occurred concurrently in the solutions. Approximately 50% of the PP321 was immediately isomerized in the pH 9.0 solution. The analyses were conducted at a temperature of 25 °C.

The hydrolytic product in the pH 9 solution was (1RS)-cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylic acid, which increased to a maximum of 72% of the recovered after 30 days.

1-8 Tefluthrin: [¹⁴C]-Tefluthrin (cyclopropane or phenyl-ring labeled) was reported to be stable to abiotic hydrolysis at 25 °C in pH 5 and 7 solutions over the 30 day study. In the pH 9 solution, the observed half-life was >30 days (approximately 70% of recovered radioactivity was tefluthrin after 30 days).

The major cyclopropyl labeled degradate in the pH 9 solution was (1RS)-cis-(ZE-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylic acid, which increased steadily to a maximum of 32.6% of recovered at day 30.

The major phenyl-labeled degradate was 2,3,5,6-tetrafluoro-4-methylbenzyl alcohol, which increased steadily to a maximum of 20.9% of the recovered at 30 days posttreatment.

Up to 5.4% of the recovered radioactivity remained unidentified.

1-9) Tralomethrin: Tralomethrin, at 10 ppm and 50 ppm, was not significantly hydrolyzed in pH 3, 6, 7, and 9 buffered solutions kept at room temperature for 30 days. Some (10%) epimerization from the S to the R isomer occurred in the pH 9 solution only. It is noted that the concentrations of the test solutions were well above the solubility limit (0.002 mg/L or 0.002 ppm), which may have caused a decrease in the hydrolysis rate of tralomethrin.

1-10) Permethrin: Permethrin is stable to hydrolysis at pH's 3 and 6 when stored in the dark at 25, 35 and 45°C for intervals up to 28 days. At pH 9, 25C alcohol and acid labeled permethrin degraded with a half-life of 125 and 350 days, respectively. Three hydrolysis products were identified: 3- phenoxybenzyl alcohol (PBA) and cis/trans 3-(2,2-dichlorovinyl)-2,2-dimethyl-cyclopropanecarboxylic acid (cis/trans DCVA).

In another study, Cis and trans Permethrin is stable to hydrolysis at pH's 5.7, 7.6 at 25C and degrades slowly at pH 9.6. Half-lives of greater than 200 days were calculated for the cis/trans isomers at pH's 5.7 and 7.6. The cis and trans isomers at pH 9.6, 25C degraded with a half-life of 60 and 40 days respectively. Again, three hydrolysis products were identified: 3-phenoxybenzoic alcohol (PBA) and cis/trans 3-(2,2-dichlorovinyl)-2,2-dimethyl-cyclopropanecarboxylic acid (cis/trans DCVA).

2. AQUEOUS PHOTOLYSIS

2-1) Bifenthrin: Bifenthrin appeared to be approximately stable to direct aqueous

photolysis over the 30 day study duration. EFED computed overall half-lives of 276 days ($r^2 = 0.785$; $n = 6$) and 417 days ($r^2 = 0.483$; $n = 6$) for ^{14}C -cyclopropyl and ^{14}C -phenyl labeled bifenthrin, respectively, in sterile aqueous solution exposed to sunlight. Such grossly extrapolated half-lives based on a 30 day study are not accurate and are of limited value other than to qualitatively indicate substantial persistence. EFED was unable to calculate direct aqueous photolysis half-lives from the overall half-lives because dark control values were provided only at day 30. There appeared to be little difference between the dark controls and the sunlight irradiated solutions on day 30. At day 30, 93.4% and 96.6% of the applied radioactivity was recovered as ^{14}C -cyclopropyl- and phenyl-labeled bifenthrin, respectively, in the dark controls compared to only slightly lower values of 91.6% and 92.7% recovered on day 30 from the sunlight irradiated solutions.

2-2) Cyfluthrin: EFED calculated an overall half-life of 4.5 days ($r^2 = 0.746$, $n = 5$) for ^{14}C -phenyl labeled cyfluthrin in aqueous solution exposed to sunlight compared to an essentially stable dark control. Since the degradation rate constant in the dark control was essentially zero, the overall half-life of 4.5 days in the sunlight irradiated solution is approximately equal to the direct photolysis in water half-life.

The major phenyl labeled degradates were 4-fluro-3-phenoxybenzaldehyde and 4-fluro-3-phenoxy benzoic acid. The parent cyfluthrin accounted for 89% of the applied on day 0. The degradate 4-fluro-3-phenoxybenzaldehyde increased from 2% of applied on day 0 to 10% (day 1), 16% (day 3), and 18% (day 7). It then declined to 12% on day 14. The degradate 4-fluro-3-phenoxybenzoic acid steadily increased from 2% of applied on day 0 to 21% (day 1), 28% (day 3), and 33% (day 7), and 37% (day 14).

Studies using radiolabeling on the cyclopropane side of the ester linkage were not conducted and cold analyses were not performed on the phenyl labeled studies. Consequently, there were no analyses for potential cyclopropane containing degradates originating from the cleavage of the carboxylate ester linkage.

2-3) Cypermethrin: EFED calculated an overall half-life of 36.2 days ($r^2 = 0.956$, $n = 5$) for ^{14}C -cyclopropyl labeled cyfluthrin in aqueous solution exposed to sunlight compared to an essentially stable dark control. Since the degradation rate constant in the dark control was essentially zero, the overall half-life of 36 days for the cyclopropyl labeled cypermethrin in the sunlight irradiated solution is approximately equal to the direct photolysis in water half-life.

EFED calculated an overall half-life of 20 days ($r^2 = 0.949$, $n = 6$) for ^{14}C -benzyl labeled cyfluthrin exposed to sunlight compared to an essentially stable dark control. Since the degradation rate constant in the dark control was essentially zero, the overall half-life of 20 days for benzyl labeled cypermethrin in the sunlight irradiated solution is approximately equal to the direct photolysis in water half-life.

The major individual cyclopropyl labeled degradate was not identified. It steadily increased to 21.2% of applied on day 30 in the sunlight irradiated solution compared to 5.8% of applied on day 30 in the dark control. The degradate trans-DCVA was detected at a maximum of 4.5% (day 14) in the sunlight irradiated solution compared to a maximum of 0.8% (day 14) in the dark control.

The major benzyl labeled degradate was 3-phenoxy benzoic acid which steadily increased from below its DL at day 0 to 2.7% (day 7), 17.4% (day 14), 18.3% (day 21), 23.4% (day 28), and 34.6% (day 35) in the sunlight irradiated solution compared to a maximum of 8.1% (day 28) in the dark control.

2-4) Deltamethrin: Deltamethrin appeared to be approximately stable to direct aqueous photolysis over the 30 day study duration.

2-5) Fenpropathrin: [¹⁴C]-Fenpropathrin (cyclopropyl and phenyl ring labeled), at approximately 5 ppb, did not degrade in sterile aqueous pH 5 buffer solutions containing 8% acetonitrile as cosolvent. The solutions were irradiated with sunlight in California for 30 days (mid fall), and kept at about 24°C. Fenpropathrin did not degrade in similar solutions kept in the dark. Unidentified [¹⁴C] compounds totaled ≤4.4% of the applied in all solutions at all sampling intervals.

The registrant reported degradation half-lives of 226-311 days for the irradiated solutions and 183 days for the dark control ($R^2 \leq 0.56$). These extrapolated half-lives based on a 30 days study are not accurate and are of limited value other than to qualitatively indicate substantial persistence.

2-6) Fenvalerate: [¹⁴C]-Chlorophenyl labeled fenvalerate, at 0.0015 ppm, degraded with a registrant-calculated half-life of 6 days in sterile aqueous pH 5 buffered solutions at 25°C, irradiated with an artificial light source (xenon burner) for 7 days. In contrast, in the dark control, [¹⁴C]-fenvalerate degraded with a registrant-calculated half-life of 13.8 days. EFED notes that there is a discrepancy between the results observed in the hydrolysis study and the dark control in the photolysis in water study.

One major degradates was 4-chloro- α -(1-methylethyl)benzeneacetic acid (CPIA) increased throughout the study to a maximum of 27.2% of total radioactivity at 7 days (last test interval). This degradate was not present in the dark control.

4-Chloro- β -(1-methylethyl)- α -(3-phenoxyphenyl)benzenepropanitrile (decarboxy-fenvalerate) was first observed on day 3 (7.9% of total radioactivity). It was 12.4-12.6% of total radioactivity on days 5 and 7. This degradate was not present in the dark control.

rac-cyano(3-phenoxyphenyl)methyl 4-chloro- α -(1-methylethyl)benzeneacetate (racemic fenvalerate) was a maximum of 21.6% of total radioactivity at 2 days. It decreased slowly

to 13.3% of total radioactivity at 7 days. In the dark control this degradate increased gradually to a maximum of 28.4% at 7 days (last test interval).

2-7) Cyhalothrin: The aqueous photolysis half-life was approximately 30 days with three major degradates reported, each being <10% of the applied.

(1RS)-cis- and (1RS)-trans-3(ZE-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylic acid (degradates Ia and Ib, and

(RS)- α -amido-3-phenoxybenzyl-(1RS)-cis, trans-3-(ZE-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate (deg !!).

2-8) Tefluthrin: [¹⁴C]-Tefluthrin (cyclopropane- and phenyl-ring-labeled), at 0.02 µg/L, in a sterile buffered pH 7 aqueous solution, irradiated with a xenon arc lamp, isomerized steadily, with an observed half-life of >31 days. The major transformation product observed was trans-tefluthrin, which resulted in approximately 37% isomerization. Less than 5% were minor degradates after 31 days. After 31 days, 60-63% of the applied remained undegraded. In contrast, [¹⁴C]-tefluthrin was stable in the nonirradiated pH 7 control solutions.

2-9 Tralomethrin: Tralomethrin photodegraded in aqueous solution containing a mixture of emulsifiers, to improve the solubility, with an estimated half-life of 1 hour. The major degradation product was deltamethrin two minor degradates (<10%) were detected and identified. The pH of the aqueous solution was not reported in the review.

In a supplementary study from the published literature (Ruzo, L.O., Casida, J.E., J. Agric. Food Chem., Vol. 9, #4, 1981), tralomethrin in various solvents (methanol, 2-propanol, benzene, and cyclohexane) was artificially irradiated with UV for 0.5-3 hours or exposed to sunlight for 5 hours. Delatamethrin appeared to degrade rapidly. In all cases, the major photoproduct was deltamethrin (a debrominated product).

This supplemental study was conducted with [¹⁴C]deltamethrin, a major degradate of tralomethrin, at 0.1 ppm, was added to unsensitized (1% acetonitrile) and sensitized (1% acetone + 1% acetonitrile) filter sterilized buffered pH 5 solutions and exposed to a sunlamp. In the nonsensitized irradiated test solutions, [¹⁴C]-deltamethrin decreased from 72.5% of the recovered at day 0 to 49.9% at day 30. In the sensitized irradiated test solution, [¹⁴C]-deltamethrin decreased from 73.0% of the recovered at day 0 to undetectable at day 30. This study is supplemental because it appears that an undetermined fraction of the deltamethrin may have been adsorbed to the walls of sample vials. In another study conducted on deltamethrin, it was found to be stable to aqueous photolysis over a 30 day study period.

2-10) Permethrin: Permethrin degraded with a calculated half-life of 79.7 days in a pH

5 solution at 25C under continuous irradiation from a Xenon arc lamp.

3. PHOTODEGRADATION ON SOIL

3-1) Bifenthrin: EFED computed overall (including non-photolytic processes) half-lives of 147 days ($r^2 = 0.947$; $n = 6$) and 98.5 days ($r^2 = 0.814$; $n = 6$) for ^{14}C -cyclopropyl- and phenyl-labeled bifenthrin on a thin layer of Dunkirk silt loam soil exposed to sunlight. EFED calculated a photodegradation on soil half-life of 106 days for the phenyl-labeled bifenthrin by subtracting the dark control rate constant from the irradiated rate constant. The photodegradation on soil half-life for the cyclopropyl labeled bifenthrin (147 days) is approximately the same as the overall half-life because there was no significant decline of bifenthrin in the dark control over the 30 day duration of the study.

The extrapolated photodegradation on soil half-lives based on a 30 day study are not accurate and are of limited value other than to qualitatively indicate substantial persistence.

No individual degradates accounted for $\geq 10\%$ of applied and therefore none are classified as major degradates.

3-2) Cyfluthrin: EFED computed an overall half-life of 5.3 days ($r^2 = 0.956$, $n = 6$) for ^{14}C -phenyl labeled cyfluthrin on a thin layer of sandy loam soil (9% clay, 2.2%OM, pH 5.4) exposed to sunlight compared to 97.9 days ($r^2 = 0.956$, $n = 6$) for the dark control. EFED calculated a photodegradation on soil half-life of 5.6 days for the phenyl-labeled cyfluthrin by subtracting the dark control rate constant from the irradiated rate constant.

The only major phenyl labeled degradate was 4-fluoro-3-phenoxybenzaldehyde. The parent phenyl labeled cyfluthrin accounted for 99% of applied at day 0. The degradate 4-fluoro-3-phenoxybenzaldehyde increased from $< 1\%$ of applied at day 0 to 10% (day 1), 12% (day 2), 15% (day 3), 17% (day 4), and 18% (days 5 and 6). It accounted for $\leq 1\%$ of applied in samples collected from the dark control over a 6 day study duration.

Degradates 2-amino-1-(4-fluoro-3-phenoxyphenyl)-2-oxoethyl-3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylate; 4-fluoro-3-phenoxybenzoic acid; and -[[[3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropyl]carbonyl]oxy]-4-fluoro-3-phenoxybenzeneacetic acid accounted for a maximum of 7%, 6%, and 3% of applied, respectively, on the last day of exposure (day 6).

Studies using radiolabeling on the cyclopropane side of the ester linkage were not conducted and cold analyses were not performed on the phenyl labeled studies. Consequently, there were no analyses for potential cyclopropane containing degradates

that may have originated from the cleavage of the carboxylate ester linkage.

3-3 Cypermethrin: EFED computed an overall half-life of 56.5 days ($r^2 = 0.987$, $n = 6$) for ^{14}C -cyclopropyl labeled cypermethrin on a thin layer of sandy loam soil (11% clay, 1.8%OM, pH 6.9) exposed to sunlight compared to 100 days ($r^2 = 0.860$, $n = 6$) for the dark control. EFED calculated a photodegradation on soil half-life of 128 days for the cyclopropyl-labeled cyfluthrin by subtracting the dark control rate constant from the irradiated rate constant.

EFED computed an overall half-life of 56.2 days ($r^2 = 0.950$, $n = 6$) for ^{14}C -phenyl labeled cypermethrin on a thin layer of sandy loam soil (11% clay, 1.8%OM, pH 6.9) exposed to sunlight compared to 75.9 days ($r^2 = 0.750$, $n = 6$) for the dark control. EFED calculated a photodegradation on soil half-life of 215 days for the phenyl-labeled cyfluthrin by subtracting the dark control rate constant from the irradiated rate constant.

The major cyclopropyl labeled and phenyl labeled degradate was cypermethrin amide which steadily increased on both the irradiated soil and on the dark control. In the cyclopropyl labeled study, cypermethrin amide accounted for a maximum of 10% (day 35) on the irradiated soil compared to a maximum of 12.8% (day 35) on the dark control soil. In the phenyl labeled study, cypermethrin amide accounted for a maximum of 9.2% (day 35) on the irradiated soil compared to a maximum of 13.3% (day 35) on the dark control soil.

3-4) Deltamethrin: For ^{14}C -gem(dimethyl) labeled deltamethrin on a thin soil layer continuously exposed to a xenon lamp, EFED computed overall half-lives of 8.9 days ($r^2 = 0.987$; $n = 6$) and 9.1 days ($r^2 = 0.993$; $n = 6$) for replicate systems A and B, respectively, compared to dark control half-lives of 10.9 days ($r^2 = 0.968$, $n = 3$) and 10.1 days ($r^2 = 0.978$, $n = 3$). By subtracting the dark control rate constants from the irradiated rate constants, EFED calculated photodegradation half-lives of 48 days and 93.1 days for replicates A and B, respectively, continuously exposed to a xenon lamp. Comparable intensities were reported for the xenon lamp and sunlight at noon. However, the photodegradation on soil half-lives for exposure to sunlight should be $> 2\text{X}$ those for continuous exposure to the xenon lamp assuming only 12 hours per day sunlight and that sunlight intensity for most of the day will be less than at noon.

The above half-lives were computed based upon the decline of "delta-isomers" which presumably consisted primarily of the parent cis-S-deltamethrin isomer, but may have also consisted of the optical cis-R-isomer and geometric trans- isomers. An analyses for specific deltamethrin isomers on day 14 and day 30 indicated that most of the deltamethrin was the original parent cis-S-isomer. The trans isomers were not detected, but the cis-R-isomer made up a small percentage of the total deltamethrin in the day 14 sample.

There was insufficient data provided for the ^{14}C -benzyl labeled deltamethrin study (a preliminary 14 day study) to compute photodegradation on soil half-lives.

For the ^{14}C -gem(dimethyl) labeled deltamethrin study, the major degradate was 3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylic acid referred to hereafter as Br₂CA. It was not specified whether it was just the cis- isomer or a mixture of the cis- and trans isomers of Br₂CA. In the irradiated system, Br₂CA accounted for an average maximum of 39.7% of applied at day 21 compared to an average maximum of 53.9% of applied at day 30 in the dark controls. For the ^{14}C -benzyl labeled deltamethrin 14 day preliminary study, the major degradate was 3-phenoxybenzoic acid referred to as 3-PBAcid. In the irradiated system, 3-PBAcid accounted for a maximum of 11.4% of applied at day 14 compared to a non-detect in the dark control.

3-5) Fenpropathrin: [^{14}C]-Fenpropathrin (cyclopropyl and phenyl ring labeled), at 112-120 $\mu\text{g/g}$, was relatively stable on sandy loam soil that was irradiated with sunlight in California for 30 days at about 21°C. After 30 days of irradiation [^{14}C]-fenpropathrin comprised 97.0-99.3% of the applied in the irradiated samples, and 90.8-94.3% in the dark controls.

The registrant reported calculated half-lives of 221-995 days for the irradiated soils, and 416 days for the dark control ($R^2 \leq 0.70$). These extrapolated half-lives based on a 30 days study are not accurate and are of limited value other than to qualitatively indicate substantial persistence.

One degradate, alpha-carbamoyl-3-phenoxybenzyl-2,2,3,3-tetramethyl-cyclopropane carboxylate (CONH₂-fenpropathrin), was a maximum of 5.6 and 10.9% of the applied, for the irradiated and dark control samples, respectively.

3-6) Fenvalerate: [^{14}C -chlorophenyl]-esfenvalerate did not photodegrade significantly in a sandy loam soil maintained at 75% of field capacity exposed to natural sunlight (Richmond, CA) for 30 days. In both the light exposed sample and the dark control, approximately 90% of the initially applied was [^{14}C]-esfenvalerate after 30 days. No significant degradation products accounted for greater than 3% of the applied radioactivity.

3-7) Cyhalothrin: Cyclopropane and phenyl-labeled [^{14}C]-PP321, at 40 g/ha, degraded slowly, with half-lives of $\gg 166$ hours (equivalent to ~34-35 days of Florida Summer sunshine) on loam soil (24.8% clay, 4.97% OM, pH 6.45) irradiated with artificial at 25°. PP321 comprised ~83-83% of the applied radioactivity after 166 hours of exposure to the artificial light source. In the dark control, 73-84% of the applied was PP321 after 30 days of incubation.

The major degradate observed for both the phenyl labeled and cyclopropane-labeled materials was (RS)- α -amido-3-phenoxybenzyl-(1-RS)-cis,trans-3-(ZE-2-chloro)-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropane carboxylate, with approximately 5% of the applied after 166 hours. Various other degradates were observed at <4% of the applied. Some of these degradates were identified.

In the dark control, the major degradate was deg. II (the same than for the irradiated samples) and it comprised about 16-17% of the applied after 30 days of incubation.

3-8) Tefluthrin: [^{14}C]-Tefluthrin (cyclopropane and phenyl-ring labeled), at 600 g ai/ha, degraded with half-lives of >31 days on loam soil (46.8% sand, 28.4% silt, 24.8% clay, 4.97% OM, pH 6.45) irradiated with a xenon arc light (4.5 hours of irradiation/day, equivalent to 12 hours of Florida Summer sunshine), maintained at 25°C.

In the irradiated samples, tefluthrin was 92.0-95.5% of the applied immediately posttreatment, 75.3-86.5% after 22.8 days, and 58.4-79.4% 30 days posttreatment (last test interval). The major degradate, comprising a maximum of 19.3% of the applied at 30.0 days was

trans-tefluthrin [2,3,5,6-tetrafluoro-4-methylbenzyl-trans-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate].

Other minor degradates and unknown were $\leq 5.2\%$ of the applied at all test intervals.

In contrast, tefluthrin degraded very slowly in the dark controls, with >89% of the applied radioactivity remaining undegraded after 30 days of incubation.

3-9) Tralomethrin: It appears that photolysis plays a small role in degrading tralomethrin on soil surfaces. It appears that there is little difference in the degradation of tralomethrin in exposed and unexposed (control) soils. Deltamethrin was the major degradation product found.

3-10) Permethrin: A half-life of greater than 30 days was determined on a loam soil under a Xenon lamp at 25°C. Degradation products included 3-phenoxybenzyl alcohol, 3-phenoxybenzoic acid, and eight other unidentified products present at less than 10% of the applied.

4. AEROBIC SOIL METABOLISM:

4-1) Bifenthrin: EFED computed half-lives of 129 days ($r^2 = 0.996$; $n = 4$), 132 days ($r^2 = 0.774$; $n = 4$), and 250 days ($r^2 = 0.999$; $n = 4$) for ^{14}C -cyclopropyl-labeled bifenthrin at 25°C in Hagerstown silty clay loam, Cosad sandy loam, and Dunkirk silt loam soils, respectively. EFED computed half-lives of 96.9 days ($r^2 = 0.983$; $n = 4$), 115 days ($r^2 = 0.966$; $n = 4$), and 156 days ($r^2 = 0.980$; $n = 4$) for ^{14}C -phenyl-labeled bifenthrin in the same three test soils. The high r^2 values indicate that the data fit a pseudo-first order model reasonably well over the entire 180 day durations of the studies and did not exhibit biphasic characteristics.

The Hagerstown silty clay loam, Cosad sandy loam, and Dukirk silt loam test soils had organic matters of 2.3%, 3.0%, and 3.1%, respectively, and pHs of 7.5, 7.0, and 7.1, respectively.

No individual degradates accounted for $\geq 10\%$ of applied and therefore none are classified as major degradates. However, the studies were only conducted for 180 days. The minor degradate accounting for the greatest % of applied in both the cyclopropyl- and phenyl-labeled studies was 4"-OH-bifenthrin (a maximum of 3-5.6% of applied).

4-2) Cyfluthrin: EFED computed half-lives of 73.5 days ($r^2 = 0.969$, $n = 5$) and 94.8 days ($r^2 = 0.925$, $n = 5$) for ^{14}C -fluorophenyl labeled cyfluthrin in a German loam soil (23% clay, 1.8% OM, pH 6.2) and a German sandy loam soil (19% clay, 1.8% OM, pH 5.9), respectively.

On day 14, the parent ^{14}C -fluorophenyl labeled cyfluthrin accounted for 86% and 84% of applied in the loam and sandy loam soils, respectively. $^{14}\text{CO}_2$ continually increased in the loam and sandy loam soils from 6% and 5% of applied on day 14 to maximums of 32% and 36%, respectively, on the last day of the studies (day 190). The only fluorophenyl degradate detected at appreciable levels was 4-fluoro-3-phenoxy benzoic acid. In the loam soil, it decreased from 7% of applied at day 14 to 5% (day 28), 3% (day 56), 2% (day 84), and 1% (day 190). In the sandy loam, it increased from 7% of applied on day 14 to 10% on day 28, then declined to 3% (day 56), 5% (day 84), and $< 1\%$ (day 190).

Studies using radiolabeling on the cyclopropane side of the ester linkage were not conducted and cold analyses were not performed on the phenyl labeled studies. Consequently, there were no analyses for potential cyclopropane containing degradates that may have originated from the cleavage of the carboxylate ester linkage.

4-3) Cypermethrin: EFED computed half-lives of 60.7 days ($r^2 = 0.952$, $n = 11$) and 59.8 days ($r^2 = 0.991$, $n = 11$) for ^{14}C -cyclopropyl labeled and ^{14}C -phenyl labeled cypermethrin in a sandy loam soil (11% clay, 1.8%OM, pH 6.9, soil moisture 75% FC) incubated in the dark at 25°C under aerobic conditions.

In the cyclopropyl labeled study, the major degradates were CO_2 and a mixture of cis- and trans-3-(2,2-dichloroethyl)-2,2-dimethylcyclopropane carboxylic acid (referred to hereafter as DCVA). The CO_2 steadily increased to a maximum of 35.8% of applied (day 128). The DCVA cis/trans mixture increased to a maximum of 24.2% of applied on day 62 and then decreased to 18.1% (day 91), 7.9% (day 122), and 4.4% (day 150).

In the phenyl labeled study, the major degradate was CO_2 which steadily increased to a maximum of 46.1% of applied on the last day (day 150) of the study. The degradate 3-phenoxybenzoic acid increased to a maximum of 8.4% of applied on day 30 and then declined to 5.8% (day 44), 6.6% (day 62), 4.4% (day 91), 3.5% (day 122), and 1.7% (day 150).

In supplemental studies, EFED computed much shorter half-lives of 2.7 days ($r^2 = 0.982$, $n = 5$), 7.3 days ($r^2 = 0.971$, $n = 5$), and 6.9 days ($r^2 = 0.983$, $n = 5$) for ^{14}C -benzyl labeled

cypermethrin in a British clay loam soil (12.2%OM, pH 7.5), a British loamy sand soil (1.8%OM, pH 6.1), and a British peat soil (72.7%OM, pH 7.4), respectively. $^{14}\text{CO}_2$ steadily increased in all 3 test soils to 69.3%, 60.3%, and 62.1% of applied, respectively on the last day of the study (day 25). The only benzyl labeled degradate accounting for > 10% of applied in any of the soils was 3-phenoxybenzoic acid which reached maximums of 9.0% (day 1) in the clay loam, 4.6% (day 1) in the loamy sand, and 12.3% (day 1) in the peat soil.

4-4) Deltamethrin: Deltamethrin at 25°C in the dark is susceptible to moderate rates of transformation in the laboratory in various soils under aerobic conditions. Reported half-lives for deltamethrin in Dubbs sandy loam and in Memphis silt loam soils were 11-19 days. The principal degradative pathway appears to involve hydrolysis of the ester linkage to form Br2CA (3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylic acid) and MPBAcid (m-phenoxybenzoic acid followed by mineralization to CO_2). Although the maximum % of applied was not provided for Br2CA or PBAcid, 52-77% of applied was reported to have been evolved as $^{14}\text{CO}_2$ by the end of the 128 day studies.

The Dubbs sandy loam and Memphis silt loam had organic matters of 1.0 and 0.7, pHs of 5.9 and 5.8, and soil moistures of 23.7% and 37.6% of 1/3 bar, respectively.

In a supplemental study conducted on the Dubbs sandy loam to determine the effect of temperature, half-lives of 46, 13, and 27 days were reported for deltamethrin incubated at 10°C, 25°C, and 40°C, respectively.

Since the hydrolysis of deltamethrin increases with increasing pH, another study was performed on an Arizona alkaline sandy loam soil (0.5%OM; pH of 8.1; 23.4% of field capacity) for comparison to the studies conducted on acidic soils and discussed above. Half-lives of 25.5 days ($r^2 = 0.980$, $n = 10$) and 21.6 days ($r^2 = 0.995$, $n = 10$) were reported for ^{14}C -gem(dimethyl) and benzyl-labeled deltamethrin, respectively.

In both the gem- and benzyl-labeled studies, a total of 50% and 61% of applied, respectively, evolved as $^{14}\text{CO}_2$ by the end of the 181 day study. In the gem-labeled study, Br2CA obtained a maximum of 26% of applied on day 15, then steadily declined to < 10% by day 60. In the benzyl-labeled study there were no other major degradates. Although the theoretical degradate 3-PBAcid was expected, it was not detected.

4-5) Fenpropathrin: [^{14}C]-Fenpropathrin (benzyl ring labeled), at ~10 ppm, degraded moderately rapid, with a registrant calculated half-life of 152 days (correlation coefficient, $r^2=0.998$), in a silt loam soil (10% clay, 1.0% O.M., pH 7.7), maintained under aerobic conditions at ~20°C.

Fenpropathrin was 9.55 ppm immediately after treatment, 9.40 ppm by day 61

posttreatment and 1.87 ppm by day 365. Various minor metabolites were identified and quantitated: PB-Acid (maximum 1.25% of the applied), CONH₂-fenpropathrin (0.21%), desphenylfenpropathrin (0.55%), and 4'-OH-fenpropathrin (0.039%).

Four other minor degradates were observed at ≤0.34% of the applied.

¹⁴CO₂ was 59.9% of the initial dose after 365 days. Non-extractable fenpropathrin residues totaled 17.8% of the initial dose after 365 days.

4-6) Esfenvalerate: 4''-chloro-(2'''-isopropyl)phenylaceto-2-(3'-phenoxy)phenyl-acetonitrile, the SS-isomer of fenvalerate degraded with a half-life of 75 days ($r^2=0.95$) in silt loam soil moistened to ~81% of field capacity and incubated in the dark at 25°C for 90 days. In contrast, the SS-isomer, when applied to the soil as part of the racemic mixture of the SS, RR, RS and SR isomers, degraded with a half-life of 95 days ($r^2=0.99$) under similar conditions.

For the SS isomer, after 90 days of incubation, 21.5% of the applied [¹⁴C] was evolved as ¹⁴CO₂, and 27.5% was bound to the soil. In the racemic mixture, after 90 days of incubation, 13.6% of the applied [¹⁴C] was evolved as ¹⁴CO₂, and 18.3% was bound to the soil.

Various degradates were detected at <2% of the applied.

4-7) Cyhalothrin: [¹⁴C]-Cyhalothrin (cyclopropane labeled), at 0.46 μg a.i./g, degraded with a 50% dissipation time (DT₅₀) of <30 days in sandy loam soil (22% clay, 4.0% O.M., pH 6.7) at 40% of the moisture holding capacity and 20°C.

The major degradates were (1RS)-cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylic acid (was 5.1-6.2% of the applied on days 30-92), (RS)-α-cyano-3-(4-hydroxyphenoxy)benzyl-(1RS)-cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate (was a maximum of 12.1% of the applied on day 63), and ¹⁴CO₂ (accounted for 35.6% of the applied by day 92).

[¹⁴C]-Cyhalothrin did not isomerize in the soil during the study.

The following study provides information only about the aerobic soil metabolism of the alcohol moiety of cyhalothrin: [¹⁴C]-Cypermethrin (benzene ring labeled), at 0.2-2.0 kg a.i./ha, degraded with a half-life of <1 week in a clay loam (44.6% clay, 12.2% O.M., pH 7.5), 1-3 weeks in a loamy coarse sand (9.8% clay, 1.8% O.M., pH 6.1), and 1-3 weeks in a Fen peat (72.7% O.M., pH 7.4) soil incubated aerobically at 25°C and 40-48% of the soil moisture holding capacity.

The major degradates were 3-phenoxybenzaldehyde (up to 6.4% of the recovered), 3-phenoxybenzoic acid (up to 9% of the recovered), (RS)- α -cyano-4-hydroxy-3-phenoxybenzyl-(1RS)-cis,trans-3-(2,2-dichloro-vinyl)-2,2-dimethylcyclopropanecarboxylate (up to 4.5% of the recovered), and 3-phenoxybenzylalcohol was not detected in any extract.

By 25 weeks posttreatment, 60-70% of the applied radioactivity had been evolved as $^{14}\text{CO}_2$.

4-8) Tefluthrin: [^{14}C]-Tefluthrin (phenyl- and cyclopropane- ring-labeled), at 100 or 600 g/ha, degraded with an observed half-life (DT_{50}) of <31 days in sandy loam soil at 40% of the moisture holding capacity, and incubated in the dark at 20°C.

After 31, 60, and 94 days, carbon dioxide comprised >21%, >37%, and >44% of the applied radioactivity, respectively. Unextractable residues in the soil comprised $\leq 23\%$ of the applied.

Various minor degradates ($\leq 7.1\%$ of the applied) were detected through the 94 days of aerobic incubation:

cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropane-carboxylic acid,
2,3,5,6-tetrafluoro-4-methylbenzoic acid,
2,3,5,6-tetrafluoro-1,4-benzenedicarboxylic acid, and
4-carboxy-2,3,5,6-tetrafluorobenzyl-(1R,3R;1S,3S)-3-(Z-chloro-3,3,3-trifluoro-prop-1-enyl)-2,2-dimethylcyclopropanecarboxylate.

4-9) Tralomethrin: [methylene- ^{14}C] and [gem-methyl- ^{14}C]-tralomethrin, at 27.5 and 110 g ai/ha, was moderately persistent in a fine sandy loam (7.2% clay, 1.0% OM, pH 5.9) and two silt loams (25.2% clay, 3.0% OM, pH 5.5, and 25.2% clay, 0.7% OM, pH 5.8) maintained under aerobic conditions for 128 days at 25°C. This study is supplemental because it reports half-lives of total ^{14}C extractable residues instead of tralomethrin per sé.

Based on the combined tralomethrin and deltamethrin residues, the following half-lives were estimated:

	Estimated Half-Life (days)	
Soil Type	gem-methyl label	methylene label
Memphis silt loam	82	64
Flagan silt loam	44	39

Dubbs fine sandy loam	54	45
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The half-lives reported represent “a worst case, total residue of toxicological concern.” $^{14}\text{CO}_2$ was the end product for both radiolabels, accounting for 11.1-49.5% of the applied radioactivity, depending on soil type, labeling position and application rate.

4-10) Permethrin: Permethrin degraded with a half-life of 37 days in an English soil (Frensham sandy loam) at a treatment rate of 0.36 lb ai/A. The major degradate was CO_2 at 34-40% of applied after 6 months incubation, followed by trans-DCVA at a maximum of 10% of applied on day 14, then 3-phenoxybenzoic acid at a maximum of 12-15% by day 30. The trans-isomer of permethrin degraded more rapidly than the cis-isomer (the ratio of cis/trans isomers changed from 40/60 at day 0 to 50/50 at day 30, to 78/22 by day 365).

Results from a supplemental aerobic soil study, examining application rate effects and soil moisture content showed application rate had the greatest effect with markedly different half-lives for the 1 mg/kg (t 1/2 19-23 days) versus the 13 mg/kg rate or 4 lbs ai/A (t 1/2 = 86-113 days). The cause was attributed to microbial inhibition and/or exceeding pesticide solubility (0.02 ppm).

5. ANAEROBIC SOIL METABOLISM

5-1) Bifenthrin: Bifenthrin appeared to be approximately stable to transformation in a flooded Cosad sandy loam soil over a period of approximately 30 days. After an initial "aerobic" incubation period of 31 days, the test Cosad sandy loam was flooded and maintained under water for an additional 30 days to day 61. In the C^{14} -cyclopropyl-labeled study, bifenthrin accounted for 97.4% of applied at day 0 (the beginning of the aerobic incubation period), 82.6% of applied at day 31 (the end of the aerobic incubation period and beginning of the flooded period) and 79.6% of applied at day 61 (the end of the flooded period). In the phenyl- C^{14} -labeled study, bifenthrin accounted for 96.9% of applied at day 0, 79.6% of applied at day 31 and 75.3% of applied at day 61. In each case, the % of applied accounted for by bifenthrin was somewhat lower after 31 days of aerobic incubation than at day 0, but somewhat comparable for the beginning (day 31) and end (day 61) of the flooded period. A longer study duration under flooded conditions beyond day 61 may have resulted in a more obvious decline under flooded conditions. However, the results of the study indicate that the transformation rate under the aerobic test conditions was greater than under the flooded (possibly anaerobic) test conditions.

No individual degradates accounted for $\geq 10\%$ of applied and therefore none are classified as major degradates. However, the studies were only conducted for 61 days. The minor degradate accounting for the greatest % of applied in both the cyclopropyl- and phenyl-labeled studies was 4"-OH-bifenthrin (a maximum of 4.5-4.9 % of applied).

5-2) Cyfluthrin: After an initial aerobic incubation of 30 days in the German loam used in

the aerobic soil metabolism study, ^{14}C -fluorophenyl labeled cyfluthrin accounted for 39% of applied. The soil was then flooded with water and the headspace purged with nitrogen to try to establish anaerobic conditions. After 30 days of presumably anaerobic conditions (not demonstrated), the ^{14}C -fluorophenyl labeled cyfluthrin dropped from 39% of applied to 21% of applied. While that appears to roughly correspond to a 30 day half-life, 2 data points are inadequate to compute one.

There were no major ^{14}C -fluorophenyl labeled degradates formed during the 30 day "anaerobic" period. However, two degradates detected at the end of the initial aerobic incubation period declined during the anaerobic phase. The degrade 4-fluoro-3-phenoxybenzoic acid declined from 10% of applied to 4% of applied. The cyfluthrin amide degrade declined from 3% of applied to 1% of applied.

5-3) Cypermethrin: After an initial aerobic incubation of 32 days in the sandy loam soil used in the aerobic study, ^{14}C -cyclopropyl and ^{14}C -phenyl labeled cypermethrin accounted for 65.9% and 67.2% of applied, respectively. The soil was then flooded with water to try to establish anaerobic conditions. Based upon cypermethrin declines during 60 days of flooded conditions (presumably anaerobic but not demonstrated), EFED computed "anaerobic" soil metabolism half-lives of 51.5 days ($r^2 = 0.986$, $n = 5$) and 62.9 days ($r^2 = 0.919$, $n = 5$) for cyclopropyl labeled and phenyl labeled cypermethrin, respectively.

The major ^{14}C -cyclopropyl labeled degradate was a mixture of cis- and trans-3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid hereafter referred to as DCVA. DCVA increased from 14% of applied on day 0 of the flooded period to 26.7% (day 14), 33.3% (day 30), 33% (day 45), and 26.3% (day 60). $^{14}\text{CO}_2$ steadily increased from 4.8% of applied on day 0 of the flooded period to 5.8% (day 14), 6.2% (day 30), 7.2% (day 45), and 10.9% (day 60).

The major ^{14}C -phenyl labeled degradate was 3-phenoxybenzoic acid which steadily increased from 7.5% of applied on day 0 of the flooded period to 16.3% (day 14), 19.1% (day 30), 25.5% (day 45), and 25.9% (day 60). $^{14}\text{CO}_2$ increased from 13.2% of applied on day 0 of the flooded period to 18.6% (day 14), 13.2% (day 30), 18.8% (day 45), and 20.9% (day 60).

5-4) Deltamethrin: After an initial aerobic incubation of 15 days in the Arizona sandy loam used in the aerobic soil metabolism study, ^{14}C -gem(dimethyl) and ^{14}C -benzyl labeled deltamethrin accounted for 54% and 51% of applied, respectively. The soil was then flooded and the headspace purged with nitrogen to try to establish anaerobic conditions. Based upon declines during the 90 day flooded period, EFED calculated (presumably anaerobic soil) half-lives of 35.6 days ($r^2 = 0.964$, $n = 4$) and 31.4 days ($r^2 = 0.953$, $n = 4$) at 25°C for ^{14}C -gem(dimethyl) and benzyl labeled deltamethrin, respectively, in soil under flooded/nitrogen atmosphere conditions.

For the GEM label, cumulative $^{14}\text{CO}_2$ increased from 4% of applied on day 0 of anaerobic conditions to 13% of applied on day 90 of anaerobic conditions. The only other major degradate was Br2CA which increased from 4% of applied on day 0 to 49% of applied on day 30, and then remained relatively stable at 52% (day 59) and 48% (day 90).

For the benzyl label, cumulative $^{14}\text{CO}_2$ increased from 16% of applied on day 0 of anaerobic conditions to 71% of applied on day 90 of anaerobic conditions. No other major degradates were formed. MPBAcid was detected at a maximum of 3% on day 30.

5-5) Fenpropathrin: [^{14}C]-Fenpropathrin (phenyl-ring labeled), at 12.0-12.3 $\mu\text{g/g}$, degraded slowly in a silt loam soil that was incubated anaerobically (flooded plus nitrogen atmosphere) for 60 days at 25°C, after 30 days of aerobic incubation. Fenpropathrin averaged 94.4% of the applied radioactivity immediately posttreatment, 85.1% following 30 days of aerobic incubation, and 66.0% following 60 days of anaerobic incubation.

During the anaerobic phase of the study, the majority of the radioactivity (79-88% of the applied) was associated with the soil fraction.

The registrant reported calculated half-lives for fenpropathrin in aerobic soil of 196 days, and 186 days in the anaerobic environment. These half-lives are of limited value because the calculations involved extrapolation considerably beyond the experimental time limits of the study.

Four degradates were detected and identified in the studies. 3-Phenoxybenzoic acid (PB-acid), averaged 2.0% of the applied immediately prior to flooding and increased to 11.5% by day 60 postflooding. PB-acid was primarily associated with the flood water. COOH-fenpropathrin averaged 1.34% of the applied immediately prior to flooding and increased to 6.36% at 60 days postflooding. COOH-fenpropathrin was mostly associated with the soil. Alpha-cyano-(4-hydroxyphenoxy)benzyl-2,2,3,3-tetramethylcyclopropanecarboxylate (4'-OH-fenpropathrin) was a minor degradate that comprised $\leq 0.35\%$ of the applied through the study. CONH₂-fenpropathrin was $\leq 0.67\%$ of the applied during the anaerobic phase.

During the anaerobic phase, unextracted radioactivity was 7.34-10.9% of the applied; volatilized [^{14}C] residues were <1% after the 90 days study. The redox potential was -7 mV at 4 hours postflooding and -192 mV after 60 days.

5-6) Fenvalerate: In an anaerobic sandy loam and two silt loam (flooded soil plus a nitrogen atmosphere), fenvalerate degraded slowly (rates similar to aerobic soil metabolism studies reported at the same time ($t_{1/2} \approx 1$ year; Dynamac 3/18/86). It appears that anaerobic soil metabolism is not an important route of dissipation for fenvalerate.

In another report (2/21/85), fenvalerate degraded in soil maintained under anaerobic

conditions with a half-life of around 6 months. It appears that no major metabolites were formed (>10% of the applied). It appears, based on these studies, that anaerobic soil metabolism is not an important route of dissipation for fenvalerate.

5-7) Cyhalothrin: [^{14}C]-Cyhalothrin (cyclopropane labeled) (60:40 mixture of isomers “A” and “B,” cyhalothrin is isomer “B”), at 100 or 500 g ai/ha, degraded with an initial half-life between 14 and 30 days posttreatment in aerobic sandy loam soil. Subsequently the soil was flooded and the degradation occurred more slowly, with reported half-life of approximately 30 days. By 90 days posttreatment, 58.9% of the applied radioactivity in the mixture had evolved as $^{14}\text{CO}_2$.

5-8) Tefluthrin: [^{14}C]-Tefluthrin (phenyl and cyclopropane- ring-labeled), at 600 g/ha, degraded with an observed half-life (DT_{50}) of >30 days in anaerobic (flooded, 2 cm water) sandy loam soil incubated at 20°C in the dark.

The rate of mineralization (CO_2 production) was much slower under anaerobic conditions, compared to the aerobic conditions (comprised <33.1% of the applied after 31 days of aerobic and 63 days of anaerobic incubation).

The major non-volatile degradates were:

cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropane-carboxylic acid (<24.7% of the applied), and

2,3,5,6-tetrafluoro-4-methylbenzoic acid (<18.3% of the applied).

The majority of the radioactivity was associated with the soil (<13.8% of the applied in the water). Unextractable residues were <14.9% of the applied.

5-9) Tralomethrin: ^{14}C -gem-methyl or ^{14}C -methylene-tralomethrin were applied to a Dubbs fine sandy loam, a Flanagan silt loam, and Memphis silt loam soils at 27.5 g/ha and allowed to incubate under aerobic conditions. Then the soils were flooded and the air space was purged with nitrogen. The soils were then incubated for up to 128 days.

In the Flanagan silt loam soil, 22.1-32.3% of the applied ^{14}C -gem-methyl and ^{14}C -methylene-tralomethrin, respectively, had evolved as $^{14}\text{CO}_2$ after 32 days of aerobic incubation. An additional 11-13.4% had evolved as $^{14}\text{CO}_2$ under anaerobic conditions. Various degradation products were identified:

tetrabromomethylcyclopropanecarboxylic acid (TBVA), which decreased with time, and

cis- and trans-dibromocyclopropanecarboxylic acids (cis- and trans-DBVA).

It was noted that deltamethrin is not a major degradate under the test conditions. At day

0 of the anaerobic incubation period (30 days after aerobic incubation), the authors reported that 10%, 76%, and 19% of the applied ^{14}C was parent tralomethrin in the Flanagan silt loam, Memphis silt loam, and Dubbs fine sandy loam soil, respectively. Estimated half-lives for tralomethrin in the same soils, using the ^{14}C -gem-methyl-label, were 270, 380, and 96 days, respectively.

Calculated half-lives for ^{14}C -gem-methyl-tralomethrin were 82 days, in the Flanagan silt loam, 35 days in the Memphis silt loam, and 69 days in the Dubbs fine sandy loam soil. Based on the data available, it appears that tralomethrin would degrade moderately slowly in anaerobic environments. Ultimately the end degradation product would be CO_2 .

5-10) Permethrin: Permethrin degraded with a half-life of 204 days in an English soil (Frensham sandy loam) under anaerobic conditions at 3.2 lb ai/A (13 mg/kg). Only 1 major degradate was found for each label: cyclopropyl labeled, was trans-DCVA and the phenyl labeled compound was 3-phenoxybenzoic acid.

6. ADSORPTION/DESORPTION:

6-1) Bifenthrin: Adsorption/desorption binding isotherms based on multiple test solutions covering a range of concentrations were not developed for bifenthrin. The reported adsorption and desorption K_d values were based on single test solutions for each of the 4 test soils.

The four test soils along with reported adsorption and desorption K_d and K_{oc} values for bifenthrin are listed in the following table:

	%Clay	%OC	pH	$K_{d(ads)}$	$K_{oc(ads)}$	$K_{d(des)}$	$K_{oc(des)}$
Leon sand	3.6	0.76	6.2	992	1.31×10^5	3340	4.39×10^5
Cosad SdLm	10.4	1.18	7.0	4160	2.39×10^5	11000	6.34×10^5
Dunkirk SiltLm	14.4	1.13	7.1	5430	3.02×10^5	11600	6.45×10^5
Hagers-town Silty CILm	24.4	1.16	7.5	3690	2.75×10^5	10250	7.65×10^5

Due presumably to hysteresis, desorption soil/water partition values are 2-3X than adsorption values.

Because none of the individual degradates detected in the laboratory studies were classified as major degradates (degradates accounting for $\geq 10\%$ of applied), the registrant was not required to submit adsorption/desorption data for degradates.

6-2) Cyfluthrin: The only laboratory mobility data submitted to satisfy the data requirement were soil TLC data for cyfluthrin on six different soils. Using the Helling and Turner mobility classification system, cyfluthrin was classified as immobile in the six test soils. To help EFED develop a K_d input for modeling, the registrant later submitted a supplemental study to the division which contained a single $K_{d(ads)}$ value for one soil of 810 L/kg.

There was no mobility data submitted for degradates. However, at least some of the degradates formed from the cleavage of the carboxylate ester of some other pyrethroids with similar structures are generally far more mobile than the parent.

6-3) Cypermethrin: Data on the adsorption and desorption of cypermethrin were provided for the following four soils:

	Texture	% Clay	%OM	pH	%OC ¹
Tavares (FL)	Sand	4	0.4	6.0	0.2
Thurston (WI)	Sandy Loam	11	1.8	6.9	0.86
Georgetown (KY)	Silty Loam	20	4.5	7.4	2.3
Troy Grove	Clay Loam	31	3.9	7.0	2.0

The reported Freundlich adsorption and desorption binding constants and exponents for cypermethrin binding to the 4 test soils are as follows:

	Tavares Sand	Thurston Sandy Loam	Georgetown Silty Loam	Troy Grove Clay Loam
$K_{f(ads)}$	657	1160	1900	416
$K_{OC,ads}$	328,500	134,900	82,600	20,800
$(1/n)_{ads}$	1.25	1.33	1.47	1.16

¹%OC= $\frac{\%OM-0.35}{1.8}$, for the Tavares sand %OC=%OM/2.

r^2 (adsorp. isotherms)	0.957	0.972	0.993	0.967
$K_{f(des)}$	1260	191	602	262
$(1/n)_{des}$	1.29	1.01	1.22	1.10
r^2 (desorp. isotherms)	0.923	0.989	0.994	0.989

There are several aspects of the above data that are unusual and are as yet unexplained, the major one being lower desorption than adsorption values for 3 of the soils.

Binding isotherms and Freundlich parameters were not provided for any of the cypermethrin degradates. However, the results of an aged soil column leaching study indicated that the cyclopropyl labeled dgradate DCVA was substantially more mobile than cypermethrin and benzyl labeled degradates such as 3-phenoxybenzoic acid. Conclusions with respect to the mobility of benzyl labeled degradates should be limited by the relatively low levels of such degradates formed within the relatively short aging period of 30 days.

^{14}C -cyclopropyl labeled and ^{14}C -benzyl labeled cypermethrin were applied to the tops of 30 cm soil columns containing a sandy loam soil (11% clay, 1.8%OM, pH 6.9), aged for 30 days and then leached with 20 inches of water.

Of the total ^{14}C -cyclopropyl labeled residues added to the top of replicate soil columns, 11.3-13.6% was recovered from the leachate. Of that amount, 89-97% was identified as a mixture of cis- and trans DCVA.

Of the total ^{14}C -benzyl labeled residues added to the top of replicate soil columns, < 1% was recovered from the leachate.

6-4) Deltamethrin: Data on the adsorption and desorption of deltamethrin and/or Br2CA were provided for the following 6 soils:

	Texture	%Clay	%OM	pH
Arizona1	Sd. Lm.	11	0.1	8.5
Arizona2	Sd. Lm.	17	0.4	8.1
Arizona3	Clay	43	0.4	7.6
Mississ.	SiltyCILm	39	1.4	6.5

USA	Sd. Lm.		4.4	6.4
Missouri	Cl. Lm.		4.6	6.8

In a screening test, single test solutions were used with each test soil to determine adsorption soil/water partition coefficients K_d followed by replacement of the test solution with chemical free solution to determine desorption soil/water partition coefficients. The adsorption and desorption K_d values for each test soil as well as the organic carbon normalized adsorption and desorption K_{oc} values for deltamethrin derived from the screening test are listed in the following table.

Deltamethrin	$K_{d(ads)}$	$K_{oc(ads)}$	$K_{d(des)}$	$K_{oc(des)}$
Arizona1	1,840	3.14×10^6	2,670	4.54×10^6
Arizona2	1,800	7.66×10^5	3,380	1.44×10^6
Arizona3	2,440	1.04×10^6	6,590	2.80×10^6
Mississ.	5,830	7.05×10^5	9,390	1.14×10^6

In the definitive test, adsorption isotherms were generated and plotted as $\ln C_s$ versus $\ln C_w$ where C_s is the equilibrium mass concentration adsorbed in mass chemical adsorbed/mass soil and C_w is the equilibrium concentration in solution in mg/L. The Freundlich exponents and adsorption binding constants were computed from the slopes and exponentials of the intercepts, respectively, of the $\ln C_s$ vs. $\ln C_w$ isotherm plots. They are provided for deltamethrin in the following table along with correlation coefficients for the regressions:

Deltamethrin	$K_{f(ads)}$	$(1/n)_{ads}$	r^2
Arizona1	9,600	0.767	0.949
Arizona2	30,000	1.20	0.971
Arizona3	26,700	0.735	0.954
Mississippi	3790	1.01	0.986

In a subsequent study on a major degradate of deltamethrin, adsorption and desorption Freundlich binding constants and exponents were determined for cis-3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylic acid referred to hereafter as cis-Br2CA. Those values for the adsorption and desorption of cis-Br2CA to 5 test soils are listed in the following table:

cis-Br2CA	$K_{f(ads)}$	$(1/n)_{ads}$	$K_{f(des)}$	$(1/n)_{des}$
Arizona2	0.089	0.998	0.143	0.860
Arizona3	0.109	0.998	0.162	0.936
Mississ.	0.355	0.957	1.91	0.971
USA	0.587	0.888	2.51	0.749
Missouri	0.267	0.8357	0.401	0.479

While the high soil/water partitioning of deltamethrin indicates that it is relatively immobile, the low soil/water partitioning of the major degradate cis-Br2CA indicates that it is mobile. In addition, comparative soil column leaching and soil TLC studies have reportedly demonstrated that a more minor degradate (3-phenoxybenzoic acid) is also substantially more mobile than deltamethrin.

6-5) Fenpropathrin: Supplemental data from a Adsorption/Desorption study indicates that fenpropathrin was adsorbed strongly to soils and was immobile in silt loam sediment, sandy loam, silt loam, and clay loam soils. The single point adsorption K_d values were 64-810.

The registrant submitted additional data to upgrade this study (MRID# 44370002). These results have not been fully reviewed, but they were screened and found to be reviewable. The additional data supports the conclusion that fenpropathrin is strongly adsorbed to soils and is not expected to leach substantially. Results are as follows:

Soil Type	%OC	Freundlich, K_{ads}	Freundlich $K_{OC, ads}$	Freundlich K_{des}	Freundlich $K_{OC, des}$
sandy loam	0.79	184	23300	314	39700
silt loam	0.95	486	51100	283	29800
clay loam	1.14	252	22100	278	24400
loam	0.46	212	46200	381	82800
aquatic sediment	2.26	662	29300	912	40400

6-6) Fenvalerate or Esfenvalerate: [^{14}C]-Fenvalerate (chlorophenyl ring labeled) was immobile in columns of sand, sandy loam, loam, and silt loam soils leached with ~20 inches of water. >88% of the applied fenvalerate remained in the upper 3 cm of the

columns.

6-7) Cyhalothrin: TLC: [^{14}C]-Cyhalothrin (cyclopropane labeled), at 10 Kg a.i./ha, was immobile on loamy sand (8.3% clay, 2.2% O.M., pH 6.5) TLC plates. 66-90% of the recovered remained within 1-cm of the treated area.

The soils used in this study were obtained from the UK. Soil characteristics were compared to several US soils and it was shown that the UK soils were similar to the US soils.

Column Leaching: Aged [^{14}C]-Cyhalothrin (cyclopropane-labeled) was immobile in columns of loamy sand and sandy loam soils. The soils were treated with 0.04-0.05 Kg of cyhalothrin eq./ha. The columns were 30 cm height and were leached with about 26 inches of calcium chloride 0.01 M. No radioactivity was detected in either the leachate or in the soil below the 0 to 5 cm soil depth. [^{14}C]-residues contained the following components:

Parent cyhalothrin (23-31%),
(1RS)-cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl-2,2-dimethylcyclopropanecarboxylic acid (4-9%),
(RS)- α -cyano-3-(4-hydroxyphenoxy)benzyl-(1RS)-cis-3-(Z-2-chloro-3,3,3-trifluoroprop-1-enyl-2,2-dimethylcyclopropanecarboxylate (1-17%), and
unextractable compound (7-18%).

Batch Equilibrium: In batch equilibrium studies, [^{14}C -phenyl labeled]-PP321, at nominal concentrations of 0.02, 0.05, 0.10, and 0.20 ppm (exceed the solubility of the chemical-0.004 ppm), appeared to have very low mobility in a sand clay loam (25% clay, 2.70% O.M., pH 6.3), silt (10% clay, 0.74% O.M., pH 6.0), and two sandy loam (8% clay, 1.22% O.M., pH 6.2; 10% clay, 1.55% O.M., pH 6.6) soils. The samples were shaken for 18 hours at 4°C. Two of the soils were obtained in England and two in the US (from MS and NC). Freundlich (K_{ads}) values varied from 477 to 3064 in the sandy clay loam, 1121 to 4649 in the silt soil, 261 to 2492 for England sandy loam soil, and 911 to 4008 for the NC sandy loam soil. In the soil extracts PP321 comprised >81% of the applied radioactivity.

Column Leaching: [^{14}C]-Cypermethrin residues (benzene ring labeled), at ~0.2 Kg a.i./ha, were immobile to slightly mobile in 30 cm height columns of clay loam, loamy sand, coarse sand, and peat soils leached with ~26 inches of 0.01 M calcium chloride. The treated soils were incubated under aerobic conditions at 25°C and 40% of their moisture holding capacity.

Following aging, 26-60% of the [^{14}C] residues were cypermethrin, $\leq 0.5\%$ were phenoxybenzaldehyde, 3-10.5% were 3-phenoxybenzoic acid, and 2.6-4.3 % were (RS)- α -

cyano-4'-hydroxy-3-phenoxybenzyl-cis,trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate.

Unextractable residues accounted for 17-55% of the soil radioactivity. No radioactivity was found in the leachate of any of the columns.

In the clay loam (37.0% clay, 13.9% O.M., pH 7.8) and loamy sand (9.3% clay, 1.9% O.M., pH 6.3) soils, no radioactivity was detected below the 0 to 5 cm depth. In the coarse sand (4.6% clay, 1.0% O.M., pH 5.9) and peat (72.7% O.M., pH 7.4) only about 0.4% of the applied was found in the 5 to 10 cm depth.

6-8 Tefluthrin: Based on batch equilibrium studies, [¹⁴C]-tefluthrin, at 0.02-0.20 ppm, appeared to have a low mobility in a sandy clay loam, a silt, and two sandy loam soils.

Soil type/ texture	% clay	estim. %OC	pH	K _d (ads)	K _{OC} range	K _d (des)
England sandy clay loam	25	1.6	6.3	1100-2300	68,800- 144,000	1800-2300
England sandy loam	8	0.7	6.2	493-980	78,000- 128,000	720-1100
NC sandy loam	10	0.9	6.6	740-1100	82,000- 122,000	850-1600
MS silt loam	15	0.4	5.2	680-1700	170,000- 425,000	850-2000

The authors of this study indicate that the K_d values were underestimated, since degradates comprised up to 70% of tefluthrin residues in solution at equilibrium. It appears that there is a positive correlation between the % clay and the levels of adsorption (K_d)

6-9 Tralomethrin: Soil TLC and column studies indicate that tralomethrin is immobile in a fine sandy loam and three silt loam soils. Tralomethrin had an adsorption coefficient value of 6.12 in the fine sandy loam soil and 20 to 22 for the three silt loam soils.

Aged residues were immobile in soil columns of a fine sandy loam and silt loam soil. Aged residues were examined by column chromatography. Soil treated with ¹⁴C-tralomethrin at a rate of 0.2 lb ai/A was aged 16 or 32 days before being transferred to the top of prepared

soil columns. The columns were leached with the equivalent of ½ acre inch water per day for 45 days.

In one study, 3-phenoxybenzoic acid (PBAC), a minor degradation product of tralomethrin was found to be mobile in soil columns of silty clay, silty clay loam and loamy sand soils.

6-10) Permethrin: Batch Equilibrium (unaged). Permethrin was observed to be immobile in the five soils tested. The reported Freundlich adsorption (K_{ad}) values were 140 in the Florida sand, 217 in the Wisconsin sandy loam soil, 246 in the California clay loam soil, 236 in the Ohio silt loam soil, and 401 in the Georgia sandy loam sediment. The reported desorption constants ranged from 87.5 to 2413. The K_{oc} values ranged from 28200 to 194000.

Soil Type	%OC	Freundlich K_{ads}	Freundlich K_{oc}
sand	0.23	446	194,000
sandy loam	1.04	355	34,100
clay loam	1.2	378	31,500
silt loam	1.22	344	28,200
sediment sandy loam	1.57	1517	96,600

Batch Equilibrium (aged). It can be concluded that the permethrin degradates mPBACid and trans-DCVA have a high potential for mobility in the soils tested as they were weakly sorbed to these soils. The mPBACid was more strongly sorbed (K_{oc} values ranging from 118 to 215) to the tested soils than was trans-DCVA (K_{oc} values ranging from 18 to 48), and as indicated above also have higher K_{ad} values than the trans-DCVA. The reported Freundlich adsorption (K_{ad}) values for mPBACid (3-phenoxybenzoic acid) ranged from 0.98 (Thurston sandy loam soil) to 3.11 (Drummer silty clay soil). The K_{ad} values for trans-DCVA ((1RS)-trans-3-(2,2-dichloroethyl)-2,2-dimethylcyclopropanecarboxylic acid) ranged from 0.16 (Thurston sandy loam soil) to 0.54 (Nixon sandy loam soil). The reported desorption constants were in the same range as the adsorption K_{ad} values.

Soil Column Leaching (aged). Parent permethrin did not appear to leach in a Nebraska sandy loam soil column study but a major soil degradate (cyclopropyl label), trans-DCVA did appear to leach. In contrast, an acceptable terrestrial field study at 0.4 lbs ai/A in North Carolina (sandy loam) and Illinois (silty clay loam) showed no leaching for both parent and permethrin's two principal soil metabolites, trans-DCVA and 3-phenoxybenzoic acid. However, the concentration of the degradates at the application rate of 0.4 lbs ai/A would have been below the detection limit of 0.025 ppm.

7. FISH BIOACCUMULATION

7-1) Bifenthrin: After 42 days exposure to 0.6 to 1.4 ng/L C¹⁴-phenyl-labeled bifenthrin in flow-through exposure tanks, bluegill sunfish had reported total C¹⁴ residue BCFs of 2110X, 8720X, and 6090X in edible tissue, non-edible tissue, and whole fish, respectively. After 42 days exposure, some of the test fish were placed in bifenthrin free water for 42 days. After 42 days of depuration in bifenthrin free water, total C¹⁴ residues in the fish tissues were still 43-53% of those in the fish tissue at the beginning of the depuration phase.

For purposes of characterizing the total C¹⁴ residues in terms of individual components, some of the test fish were exposed to more elevated bifenthrin concentrations after the initial 42 day exposure period for a period of an additional 21 days (to day 63). After day 63, the total C¹⁴ residues in edible tissue were accounted for as follows: bifenthrin (70.2%), unextractable (21.4%), "unknowns" (4.8%), and 4'-OH-bifenthrin (3.6%). The total C¹⁴ residues in inedible tissue were accounted for as follows: bifenthrin (66.8%), unextractable (23.4%), "unknowns" (6.3%), and 4'-OH-bifenthrin (3.2%).

7-2) Cyfluthrin: Bluegill sunfish were exposed to a nominal concentration of 130 ng/L ¹⁴C-phenyl labeled cyfluthrin for 28 days and then placed in cyfluthrin free water for another 28 days. Measured mean exposure concentrations varied from 64 ng/L to 206 ng/L. Total ¹⁴C residue BCF values for whole fish increased to a maximum of 854 on day 14 and then fluctuated down to 684 on day 21 and up to 791 on day 21. Mean ¹⁴C residues in whole fish declined fairly rapidly in the depuration phase from 63 ug/kg on day 0 to 23 ug/kg (day 1), 25 ug/kg (day 3), 11 ug/kg (day 7), 14 ug/kg (day 14), 7 ug/kg (day 21), and 4 ug/kg (day 28). The only phenyl labeled residue detected above 50 ug/kg was the parent.

7-3) Cypermethrin: Bluegill sunfish were exposed in separate tests to nominal 0.20 ug/L ¹⁴C-cyclopropyl and ¹⁴C-benzyl labeled cypermethrin in flow-through tanks for a 28 day uptake phase. Mean measured exposure concentrations were 0.19 ug/L for the cyclopropyl labeled residues and 0.18 ug/L for the benzyl labeled residues. After 28 days of exposure the bluegill sunfish were placed in cypermethrin free water for a 21 day depuration phase.

Maximum total ¹⁴C-cyclopropyl residue BCFs were 161 (for edible tissue on day 28), 833 (for viscera on day 28), and 444 (for whole fish on day 28). BCFs gradually increased with increasing exposure time, and steady state may not have been obtained by the last day of exposure (day 28). After 21 days depuration, total ¹⁴C-cyclopropyl residues declined from 29 ug/kg to 3.2 ug/kg in edible tissues, from 150 ug/kg to 13 ug/kg in viscera, and from 80 ug/kg to 11 ug/kg in whole fish.

Maximum total ¹⁴C-benzyl residue BCFs were 111 (for edible tissue on day 28), 579 (for viscera on day 21), and 468 (for whole fish on day 21). BCFs rapidly increased with

increasing exposure time and appeared to reach approximate steady state by only 1 day of exposure for viscera and whole fish. For edible tissue, BCFs gradually increased with increasing exposure time, and steady state may not have been obtained by the last day of exposure (day 28). After 21 days depuration, total ^{14}C -benzyl residues declined from 21 ug/kg to 2.9 ug/kg in edible tissues, from 93 ug/kg to 12 ug/kg in viscera, and from 57 ug/kg to 10 ug/kg in whole fish.

7-4) Deltamethrin: After 49 days exposure to a mean 26.4 ng/L C^{14} labeled deltamethrin residues in flow-through exposure tanks, bluegill sunfish had reported total C^{14} residue BCFs of 188X, 3640X, and 698X in edible tissue, viscera, and whole fish respectively.

Approximately 78% and 83% of the extractable ^{14}C residues from the edible and viscera tissues of fish sacrificed after the last day of exposure were identified as deltamethrin. No potential degradates were detected.

Although the study discussed above did not include a depuration phase, a previous study with comparable total ^{14}C residue BCFs reported approximately 50% decline in residues 3-7 days into a depuration phase and a 70-75% reduction in residues by day 14 of the depuration phase.

7-5) Fenpropathrin: [^{14}C]-Fenpropathrin (cyclopropyl and benzyl labeled) residues accumulated in bluegill sunfish, with bioconcentration factors of 200X, 830X, and 1400X in fillet, whole fish, and viscera, respectively, after 28 days of exposure to fenpropathrin at ~0.2 ppb in a flow through system.

In the tissue, [^{14}C]-residues were 42-81% fenpropathrin, 3.6-6.5% α -cyano-3-phenoxybenzyl-2-hydroxymethyl-2,3,3-trimethylcyclo-propanecarboxylate, 0.9-13.4% 3-phenoxybenzoic acid, 0.8-7.8% 3-(4-hydroxyphenoxy)benzoic acid, 2.9-15.4% 2,2,3,3-tetramethylcyclopropanecarboxylic acid, 2.2-12.6% 2-carboxy-2,3,3-trimethylcyclopropanecarboxylic acid, and 0.3-2.5% 2-hydroxymethyl-2,3,3-trimethylcyclopropane-carboxylic acid.

Accumulated [^{14}C]-residues depurated rapidly from the viscera but more slowly from the fillet (~65% and 5% eliminated after 3 days of depuration, respectively).

7-6) Esfenvalerate: In a supplemental study, carp (*Cyprinus carpio*) were exposed to [^{14}C -Ph] or [^{14}C -Cl]-esfenvalerate at approximately 0.04 ppb in flow through system for a 28 day exposure phase. Exposure concentrations ranged from 0.046-0.061 and 0.035-0.056 ppb for the ^{14}C -Ph and ^{14}C -Cl radiolabelled test materials. Exposed fish were then placed in clean water for 14 days of depuration.

The concentration of 14 (parent plus metabolites) increased with time during the uptake phase and reached levels of 0.161-0.225 ppm. The daily bioconcentration factors ranging

from 505-3340 for the [^{14}C -Ph] label, and 503-3080 for the [^{14}C -Cl] label.

After 14 days of depuration greater than 74% of the radioactivity and more than 68% of the fenvalerate residues were eliminated. The depuration half-lives were estimated to be approximately 7-8 days.

Esfenvalerate is metabolized primarily through oxidation at the 4'-position of the alcohol moiety and the 3-position of the acid moiety, cleavage of the ester linkage and conjugations of the resultant phenol or carboxylic acid with glucuronic acid or sulfuric acid. The major metabolites observed were the glucuronide of 4'-OH-fenvalerate, 4'-OH-fenvalerate, sulfate of 4'-OH-PB acid, and CPIA and amounted to $\leq 34\%$ of the ^{14}C in fish.

Esfenvalerate isomerizes to the [2S, α S] isomer and tends to bind to glass, making it difficult to interpret the study.

7-7) Cyhalothrin: The concentration of cyhalothrin in fish appeared to stabilize within two weeks of exposure. The maximum bioconcentration factors were 2240X for whole fish, 7340X in viscera, and 850X in the remaining tissues. During the depuration phase the radioactivity eliminated from the tissues was 79% from muscle, 77% from viscera, and 78% from the remainder.

In another study channel catfish (*Ictalurus punctatus*) were exposed to [^{14}C]-cypermethrin (benzene ring labeled and its degradation products in a soil/water ecosystem for 23 days after which the fish were transferred to flowing fresh water for 14 days depuration time.

The data presented in the report show that bioconcentration of residues of the [^{14}C] benzyl moiety of cypermethrin from a sediment/water ecosystem by channel catfish is relatively minor. Rapid loss of these same residues on depuration also shows that they are unlikely to possess the potential to accumulate through a food chain involving fish.

7-8 Tefluthrin: Total [^{14}C]-tefluthrin residues accumulated in bluegill sunfish with maximum bioaccumulation factors of 750 X in the edible tissue, 12761X in the viscera, and 2051X in the whole fish during 33 days of exposure at 5-30 ng/L (average 11.5 ng/L) in a flow-through system. In the edible tissue, 61-66% of the total [^{14}C]-residues were parent tefluthrin. Depuration appeared to be slow. After 65 days of depuration, [^{14}C]-residues decreased to 1.1 $\mu\text{g/Kg}$ (from a maximum of 8.8 $\mu\text{g/Kg}$) in edible tissue, 6 $\mu\text{g/Kg}$ (from a maximum of 149 $\mu\text{g/Kg}$) in the viscera, and 2.4 $\mu\text{g/Kg}$ (from a maximum of 24.0 $\mu\text{g/Kg}$) in the whole fish.

7-9 Tralomethrin: Tralomethrin bioaccumulated with maximum bioaccumulation factors of 490X for whole fish, 6X for the edible tissue, and 920X for the non-edible tissue. The mean measured water concentration was 0.085 ppb. Bluegill sunfish were exposed to tralomethrin for 30 days in a flow-through system. The authors report that 89% of the

residues taken up in whole fish were eliminated after 21 days depuration. The nature of the identity of the ^{14}C -residues found in the fish tissues is not known.

7-10) Permethrin: Fish bioaccumulation studies showed that permethrin bioaccumulated 950-1000X in the viscera, 570-610X in the whole fish, and 180-230X in the fillet. Depuration was rapid with 73-83% depuration occurring after 14 days.

8. VOLATILITY FROM WATER AND SOIL:

8-1) Bifenthrin: Bifenthrin has a vapor pressure of 1×10^{-7} torr = 1.3×10^{-10} atm, an aqueous solubility of 1×10^{-4} mg/L = 2.4×10^{-7} mol/m³, and an estimated Henry's Law constant of 5.6×10^{-4} atm*m³/mol. Based upon its Henry's Law constant, bifenthrin is expected to have some potential for volatilization from water. However, its potential for volatilization from soil should be much lower due to its relatively high soil/water partitioning.

C^{14} -cyclopropyl-labeled bifenthrin was added to the surface of a soil maintained at a moisture of 50% or 75% of field maximum capacity (FMC), and exposed to air flow rates of 100 mL/min or 200 mL/min at 25°C or 40°C for 14 days. For each of those experimental conditions at day 14, volatile C^{14} residues accounted for the following percentages of the total C^{14} recovered:

Temperat.	%FMC	Air Flow Rate	% of Total C^{14} Recovered Accounted for by Volatiles	% of Total C^{14} Recovered
25°C	50%	100 mL/min	0.83%	98.8%
25°C	50%	300 mL/min	1.1%	111%
25°C	75%	100 mL/min	0.81%	98.6%
25°C	75%	300 mL/min	0.32%	106%
40°C	50%	100 mL/min	4.9%	98.1%
40°C	50%	300 mL/min	3.9%	102%
40°C	75%	100 mL/min	5.1%	97.8%
40°C	75%	300 mL/min	5.1%	102%

The relatively low percentages of total recovered C^{14} accounted for by volatiles coupled with the high total C^{14} recoveries indicate that the rates of volatilization from soil of bifenthrin and any of its degradates over the 14 day durations of the studies were relatively

low. Since the quantity of degradates formed during the 14 day studies were probably low, most of the C¹⁴ recovered was probably the parent bifenthrin. Although the relatively high Henry's Law constant for bifenthrin ($5.6 \times 10^{-4} \text{ atm}\cdot\text{m}^3/\text{mol}$) suggests that its potential for volatilization from water may be relatively high, its relatively high soil/water partition coefficient appears to be limiting its volatilization rate from soil. Nevertheless, its volatilization rate from soil may be comparable to rates for some other dissipation pathways, all of which appear to be relatively slow.

8-2) Cyfluthrin: Cyfluthrin has a vapor pressure of $3.3 \times 10^{-8} \text{ torr} = 4.3 \times 10^{-11} \text{ atm}$, an aqueous solubility of $1.2 \times 10^{-3} \text{ mg/L} = 2.8 \times 10^{-6} \text{ mol/m}^3$, and an estimated Henry's Law constant of $1.6 \times 10^{-5} \text{ atm}\cdot\text{m}^3/\text{mol}$. Based upon its Henry's Law constant, cyfluthrin is expected to have some potential for volatilization from water. However, its potential for volatilization from soil should be much lower due to its relatively high soil/water partitioning.

8-3) Cypermethrin: Cypermethrin has a vapor pressure of $6.7 \times 10^{-9} \text{ torr} = 8.8 \times 10^{-12} \text{ atm}$, an aqueous solubility of $0.2 \text{ mg/L} = 4.8 \times 10^{-4} \text{ mol/m}^3$, and an estimated Henry's Law constant of $1.6 \times 10^{-8} \text{ atm}\cdot\text{m}^3/\text{mol}$. Based upon its Henry's Law constant, cyfluthrin is not expected to have any significant potential for volatilization from water. Its potential for volatilization from soil should be low due to its relatively high soil/water partitioning as well as its relatively low Henry's Law constant

8-4) Deltamethrin: Deltamethrin has a vapor pressure of $1.5 \times 10^{-8} \text{ torr} = 2.0 \times 10^{-11} \text{ atm}$, an aqueous solubility of $2.0 \times 10^{-4} \text{ mg/L} = 4.0 \times 10^{-7} \text{ mol/m}^3$, and an estimated Henry's Law constant of $5.0 \times 10^{-5} \text{ atm}\cdot\text{m}^3/\text{mol}$. Based upon its Henry's Law constant, deltamethrin is expected to have some potential for volatilization from water. However, its potential for volatilization from soil should be much lower due to its relatively high soil/water partitioning.

8-5 Fenpropathrin: Fenpropathrin has a low vapor pressure of $5.48 \times 10^{-6} \text{ torr} = 7.21 \times 10^{-9} \text{ atm}$, and an aqueous solubility of $1.4 \times 10^{-2} \text{ ppm} = 4.01 \times 10^{-5} \text{ mol/m}^3$, and an estimated Henry's Law constant of $1.80 \times 10^{-4} \text{ atm}\cdot\text{m}^3/\text{mol}$. Based upon its Henry's Law constant, fenpropathrin is expected to have a small potential for volatilization from water. Its potential for volatilization from soil is lower due to its relatively high soil/water partitioning.

8-6 Fenvalerate: Fenvalerate has a vapor pressure of $1.10 \times 10^{-8} \text{ torr} = 1.45 \times 10^{-11} \text{ atm}$, an aqueous solubility of $0.002 \text{ mg/L} = 4.76 \times 10^{-6} \text{ mol/m}^3$, and an estimated Henry's Law constant of $3.04 \times 10^{-6} \text{ atm}\cdot\text{m}^3/\text{mol}$. The reported actual Henry's Law constant is $6.08 \times 10^{-8} \text{ atm}\cdot\text{m}^3/\text{mol}$. Based upon its Henry's constant, fenvalerate is not expected to have any significant potential for volatilization from water. Its potential for volatilization from soil should be low due to its relatively high soil/water partitioning as well as its relatively low Henry's constant.

In a reported study (3/18/86), chlorophenyl-labeled [^{14}C]-fenvalerate adsorbed strongly to glass, teflon, and polypropylene surfaces.

8-7 Cyhalothrin: Cyhalothrin has a low vapor pressure of 2.00×10^{-10} torr = 2.63×10^{-13} atm, and an aqueous solubility of 0.004 ppm = 8.89×10^{-6} mol/m³, and an estimated Henry's Law constant of 2.96×10^{-8} atm•m³/mol. Based upon its Henry's Law constant, fenpropathrin is expected to have a relatively small potential for volatilization from water. Its potential for volatilization from soil is even lower due to its relatively high soil/water partitioning.

8-8) Tefluthrin: Tefluthrin has a vapor pressure of 5.95×10^{-5} mm Hg = 7.83×10^{-9} atm, water solubility of 2.00×10^{-2} ppm = 4.78×10^{-5} mol/m³, and an estimated Henry's Law constant of 1.6×10^{-5} atm•m³/mol. Based upon its Henry's Law constant, tefluthrin is expected to have some potential for volatilization from water. However, its potential for volatilization from soil should be lower due to its relatively high soil/water partitioning.

In the aerobic soil metabolism study, [^{14}C]-tefluthrin recovered in the volatile traps accounted for 5.8-7.9% of the applied at 94 days posttreatment. In a supplemental field volatility experiment, [^{14}C]-residues volatilized reached 0.22-0.7% of the applied during the first 5 days of the study. Volatilized parent tefluthrin comprised 0.06-0.66% of the applied radioactivity.

8-9 Tralomethrin: Tralomethrin has a vapor pressure of 1.3×10^{-13} mm Hg = 1.7×10^{-16} atm, water solubility of 7.1×10^{-3} ppm = 1.08×10^{-5} mol/m³, and an estimated Henry's Law constant of 1.6×10^{-11} atm•m³/mol. Based upon its Henry's Law constant, tralomethrin is expected to have a low potential for volatilization from water. Its potential for volatilization from soil should be lower due to its relatively high soil/water partitioning.

8-10) Permethrin: Permethrin has a vapor pressure of 2.15×10^{-8} mm Hg = 2.83×10^{-11} atm, water solubility of 0.07 ppm = 1.8×10^{-4} mol/m³, and an estimated Henry's Law constant of 1.6×10^{-7} atm•m³/mol. Based upon its Henry's Law constant, permethrin is expected to have a relatively low potential for volatilization from water. Its potential for volatilization from soil should be lower due to its relatively high soil/water partitioning.

9. TERRESTRIAL FIELD DISSIPATION

9-1) Bifenthrin:

9-1-1) Champaign IL (1): Bifenthrin in the form of the Capture EC formulation was ground spray applied to a bare Drummer silty clay loam 5 times at an application rate of 0.2 lbs ai/acre/app. The study site received 78.8 inches of precipitation during the study compared to a 10 year average of 72.2 inches.

Multiple soil cores of depths 0-6, 6-12, and 12-18 inches were collected immediately after

each of the 5 applications and days 7, 14, 21, 30, 60, 91, 120, 150, 180, 225, 271, 363, 420, 480, and 572 after the last application. The cores were analyzed for bifenthrin and 4-hydroxy-bifenthrin.

EFED calculated a dissipation half-life of 192 days ($r^2 = 0.624$; $n = 14$ average residue values) after the last application in the top 0-6" cores.

Average immediate post-application concentrations of bifenthrin in 0-6" cores were 0.08, 0.09, 0.1, 0.19, and 0.17 mg/kg. Bifenthrin concentrations in the 0-6" cores declined from an average of 0.17 mg/kg on day 0 to 0.09 mg/kg (day 7), 0.11 mg/kg (day 14), 0.10 mg/kg (day 21), 0.16 (day 30), 0.07 mg/kg (day 60), 0.09 mg/kg (day 91), 0.1 mg/kg (day 120), 0.06 mg/kg (day 150), 0.07 (day 180), 0.14 (day 225), 0.02 (day 271), 0.03 mg/kg (day 363), 0.03 mg/kg (day 420), 0.01 mg/kg (day 480), and 0.01 mg/kg (day 572). Bifenthrin was not detected above a DL of 0.01 mg/kg in any of the soil cores deeper than 6 inches.

The only degradate for which analyses were performed (4'-OH-bifenthrin) was not detected above a DL of 0.01 mg/kg in any of the soil cores including the 0-6" cores.

9-1-2) Fresno CA (1): Bifenthrin in the form of the Capture EC formulation was ground spray applied to a San Joaquin sandy soil (at least partially covered with plant residues) once at an application rate of 1.0 lbs ai/acre. The study site received a total rainfall and irrigation combined of 21 inches during the study.

Multiple soil cores of depths 0-6, 6-12, and 12-18 inches were collected immediately after application and days 1, 7, 14, 21, 35, 91, 131, 150, 180, 225, 357, 425, 495, and 538 after application. The cores were analyzed for bifenthrin and 4-hydroxy-bifenthrin.

EFED calculated a dissipation half-life of 345 days ($r^2 = 0.290$; $n = 15$ average residue values) average residue values) for the top 0-6" core. The low r^2 value indicates that the computed half-life has little value beyond qualitatively indicating that the compound is persistent.

Bifenthrin concentrations in the 0-6" cores declined from an average of 0.92 mg/kg on day 0 to 0.48 mg/kg (day 1), 0.81 mg/kg (day 7), 0.44 mg/kg (day 14), 0.74 mg/kg (day 21), and 0.21 (day 35), and then remained at 0.15-0.29 mg/kg through day 538. Bifenthrin was detected in 6-12" cores collected on 357 (one of three cores at 0.03 mg/kg), day 425 (0.03, 0.03, and 0.04 mg/kg), day 495 (one of three cores at 0.07 mg/kg), and day 538 (0.02, 0.04, and 0.18 mg/kg). It was detected at 0.02 mg/kg in one 18-24" core collected on day 495.

The only degradate for which analyses were performed (4'-OH-bifenthrin) was detected at .01-.02 mg/kg in several 6-12" cores and in two 18-24" cores.

9-1-3) Madera CA: Bifenthrin in the form of the Capture EC formulation was ground spray applied to cotton plants in a Hanford sandy loam soil once at an application rate of 1.0 lbs ai/acre. The study site received 53.4 inches of irrigation.

Multiple soil cores of depths 0-6, 6-12, and 12-18 inches were collected immediately after application and days 30, 120, 225, and 540 after application. The cores were analyzed for bifenthrin and 4-hydroxy-bifenthrin.

EFED calculated a dissipation half-life of 155 days ($r^2 = 0.468$; $n = 21$ average residue values) for the top 0-6" core. The low r^2 value indicates that the computed half-life has limited value beyond qualitatively indicating that the compound is persistent. An examination of the Ln (residue concentrations) versus time plot submitted by the registrant indicate that the low r^2 value is due more to scatter than to any discernable biphasic pattern.

Bifenthrin concentrations in the 0-6" cores declined from 0.20-0.37 mg/kg on day 0 to 0.02-.11 mg/kg on day 30 and remained at 0.01-0.07 mg/kg through day 225. Bifenthrin was not detected in any 6-12" or 12-18" cores. However it was detected at 0.05 mg/kg in one of three 18-24" cores collected on day 225, at 0.02 mg/kg in one of three 24-30" cores collected on day 225, and at 0.01 mg/kg in one of three 30-36" cores collected on day 225.

The only degradate for which analyses were performed (4'-OH-bifenthrin) was not detected above a DL of 0.01 mg/kg in any of the soil cores including the 0-6" cores.

9-1-4) Imperial County CA: Bifenthrin in the form of the Capture EC formulation was ground spray applied to cotton plants in an Imperial-Glenbar silty clay loam soil once at an application rate of 1.0 lbs ai/acre. The study site was furrow irrigated with 34.2 inches of water.

Multiple soil cores of depths 0-6, 6-12, and 12-18 inches were collected immediately after application and days 33, 127, and 227 after application. The cores were analyzed for bifenthrin and 4-hydroxy-bifenthrin.

EFED calculated a dissipation half-life of 228 days ($r^2 = 0.385$; $n = 18$ average residue values) for the top 0-6" core. The low r^2 value indicates that the computed half-life has limited value beyond qualitatively indicating that the compound is persistent. An examination of the Ln (residue concentrations) versus time plot submitted by the registrant indicate that the low r^2 value is due more to scatter than to any discernable biphasic pattern.

Bifenthrin concentrations in the 0-6" cores declined from 0.30-0.57 mg/kg on day 0 to 0.14-0.22 mg/kg on day 33 and remained at 0.14-0.21 through day 225. Bifenthrin was not detected above a DL of 0.01 mg/kg in any of the soil cores deeper than 6 inches. The only

degradate for which analyses were performed (4'-OH-bifenthrin) was not detected above a DL of 0.01 mg/kg in any of the soil cores including the 0-6" cores.

9-1-5) Tifton GA, Marion AR (2), Fresno CA (2), Champaign IL (2): Bifenthrin in the form of a 10% WP Brigade formulation was applied once at 2 lbs ai/acre to a Tifton GA loamy sand (1.1%OM, pH 4.5), a Marion AR loam soil (0.9%OM, pH 6.4), a Fresno CA loam soil (3.9%OM, pH 6.1), and a Champaign IL loam soil (2.2%OM, pH 6.3). Cumulative rainfall during the year long studies were 57.4, 45.7, 7.1, and 97.6 inches for the GA, AR, CA, and IL sites, respectively.

At each of the 4 study sites, soil cores of 0-6" and 6-12" were collected immediately after application (day 0), and 7, 14, 30, 90, 180, 270, and 360 days after application. The soil cores were analyzed only for the parent bifenthrin.

EFED calculated dissipation half-lives of 122 days ($r^2 = 0.800$; $n = 8$), 77.7 days ($r^2 = 0.929$; $n = 7$), 193 days ($r^2 = 0.336$; $n = 6$), and 118 days ($r^2 = 0.637$; $n = 8$) for those 4 sites, respectively. The data for the GA and CA sites show some biphasic characteristics with DT50s of < 30 days, but much longer overall half-lives.

At the Georgia site, bifenthrin concentrations in the 0-6" cores declined from 1.45 mg/kg at day 0 to 0.82 mg/kg (day 7), 0.85 mg/kg (day 14), 0.39 mg/kg (day 30), 0.34 mg/kg (day 90), 0.44 mg/kg (day 180), 0.23 mg/kg (day 270), and 0.09 mg/kg (day 360). Bifenthrin was detected above a DL of 0.01 mg/kg in 6-12" soil cores collected on day 7 (0.08 mg/kg), day 14 (0.08 mg/kg), day 30 (0.06 mg/kg), and day 90 (0.03 mg/kg).

At the Arkansas site, bifenthrin concentrations in the 0-6" cores remained relatively stable at 1.3 mg/kg (day 0), 1.4 mg/kg (day 7) and 1.64 mg/kg (day 14) before declining to 0.78 mg/kg (day 30), 1.12 mg/kg (day 90), 0.44 mg/kg (day 180), and 0.05 mg/kg (day 360). Bifenthrin was detected above a DL of 0.01 mg/kg in 6-12" soil cores collected on day 0 (0.45 mg/kg), day 7 (0.01 mg/kg), day 14 (0.16 mg/kg), and day 90 (0.06 mg/kg).

At the California site, bifenthrin concentrations in the 0-6" cores declined from 0.79 mg/kg at day 0 to 0.35 mg/kg (day 7), 0.37 mg/kg (day 14), 0.14 mg/kg (day 30), and 0.08 mg/kg (day 90). It then increased to 0.38 mg/kg (day 180) before declining again to 0.17 mg/kg (day 270) and 0.07 mg/kg (day 360). Bifenthrin concentrations in the 6-12" cores initially declined from 0.21 mg/kg (day 0) to 0.18 mg/kg (day 7), and 0.07 mg/kg (day 14), and then remained relatively stable at 0.06 mg/kg (day 30), 0.04 mg/kg (day 90), 0.05 mg/kg (day 180), 0.15 mg/kg (day 270), and 0.06 mg/kg (day 360).

At the Illinois site, bifenthrin concentrations in the 0-6" cores initially remained relatively stable at 0.58 mg/kg (day 0), 1.75 mg/kg (day 7) and 1.66 mg/kg (day 14) and 1.62 mg/kg (day 30) before declining to 0.28 mg/kg (day 30) and again remaining relatively stable at 0.23 mg/kg (day 180), 0.42 mg/kg (day 270), and 0.13 mg/kg (day 360). Bifenthrin

concentrations in the 6-12" cores initially remained relatively stable at 0.14 mg/kg (day 0), 0.02 mg/kg (day 7), 0.11 mg/kg (day 14), and 0.16 mg/kg (day 30) before declining to 0.01-0.02 mg/kg on days 180, 270, and 360.

9-1-6) Champaign IL (3) and Marion AR (3): Bifenthrin in the form of a 10% WP Brigade formulation was applied once at 2 lbs ai/acre to a Champaign IL loam soil (2.2%OM, pH 6.3) and a Marion AR loam soil (0.9%OM, pH 6.4). Cumulative rainfall during the year long studies were 38.7 and 52.9 inches for the IL and AR sites, respectively.

At the IL study site, soil cores of 0-6" and 6-12" were collected immediately after application (day 0), and 7, 14, 30, 90, 183, 325, and 360 days after application. At the AR study site, soil cores of 0-6" and 6-12" were collected immediately after application (day 0), and 7, 14, 31, 179, and 270 days after application. The soil cores were analyzed only for the parent bifenthrin.

EFED calculated dissipation half-lives of 126 days ($r^2 = 0.912$; $n = 8$) and 121 days ($r^2 = 0.932$; $n = 7$) for the IL and AR sites, respectively.

At the Illinois site, bifenthrin concentrations in the 0-6" cores declined from 0.65 mg/kg at day 0 and 0.66 mg/kg (day 7) to 0.44 mg/kg (day 14), 0.28 mg/kg (day 30), 0.28 mg/kg (day 90), 0.18 mg/kg (day 183), 0.11 mg/kg (day 325), and 0.06 mg/kg (day 360). Bifenthrin was detected above a DL of 0.01 mg/kg in 6-12" soil cores collected on day 7 (0.13 mg/kg), day 14 (0.05 mg/kg), day 30 (0.04 mg/kg), day 183 (0.02 mg/kg), and day 325 (0.02 mg/kg).

At the Arkansas site, bifenthrin concentrations in the 0-6" cores initially remained relatively stable at 0.92 mg/kg from 0.65 mg/kg (day 0), 0.85 mg/kg (day 7), and 1.06 mg/kg (day 14) before declining to 0.50 mg/kg (day 31), 0.25 mg/kg (day 179), 0.16 mg/kg (day 270), and 0.13 mg/kg (day 360). Bifenthrin was detected above a DL of 0.01 mg/kg in 6-12" soil cores collected on day 7 (0.06 mg/kg), day 14 (0.02 mg/kg), and day 31 (0.02 mg/kg).

9-2) Cyfluthrin:

9-2-1) Glendale AZ: Cyfluthrin in the form of Baythroid 24%EC was sprayed once at 1 kg ai/ha to a sandy clay loam (<1%OM, pH 7.8). Soil cores of 0-6" and 6-12" were collected on days 0, 31, 60, and 119. For the 0-6" soil cores, the reviewer reported a DT50 of << 31 days. Cyfluthrin was reported to decline from 0.27 mg/kg immediately post-application (day 0) to 0.02 mg/kg on day 31. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, the degradate 3-(2,2-dichloroethenyl)-2,2-

dimethylcyclopropane carboxylic acid declined from a maximum of 0.15 mg/kg on day 60 to 0.03 mg/kg on day 119. The detections of the degradate 4-fluoro-3-phenoxybenzoic acid were all < 0.07 mg/kg in the 0-6 " cores.

None of the analytes were detected above a detection limit of 0.01 mg/kg in the 6-12" cores. However, the site received only 0.2 inches of precipitation during the study.

9-2-1) Unionville, Ontario Canada: Cyfluthrin in the form of Baythroid 20%EC was sprayed once at 1 kg ai/ha to a loam soil (3-4%OM, pH 7.0). Soil cores of 0-6" and 6-12" were collected on days 0, 30, 60, and 154. For the 0-6" soil cores, the reviewer reported a DT50 of << 30 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 0.51 mg/kg immediately post-application (day 0) to 0.05 mg/kg on day 30. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, the degradate 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid declined from a maximum of 0.16 mg/kg on day 30 to < 0.01 mg/kg on day 60. The detections of the degradate 4-fluoro-3-phenoxybenzoic acid were all < 0.01 mg/kg in the 0-6 " cores.

None of the analytes were detected above 0.02 mg/kg in the 6-12" cores. The site received 4.2 inches of precipitation during the first 30 days post-application.

9-2-3) Canby OR: Cyfluthrin in the form of Baythroid 24%EC was sprayed once at 1 kg ai/ha to a silt loam soil (3.7%OM, pH 5.0). Soil cores of 0-6" and 6-12" were collected on days 0, 32, 68, and 120. For the 0-6" soil cores, the reviewer reported a DT50 of << 32 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 3.19 mg/kg immediately post-application (day 0) to 0.03 mg/kg on day 32. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, the degradate 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid declined from a maximum of 0.10 mg/kg on day 33 to 0.05 mg/kg on day 120. The detections of the degradate 4-fluoro-3-phenoxybenzoic acid were all < 0.07 mg/kg in the 0-6 " cores.

None of the analytes were detected above a detection limit of 0.01 mg/kg in the 6-12" cores. However, the site received only 0.5 inches of precipitation during the first 30 days post-application.

9-2-4) Benoit MS: Cyfluthrin in the form of Baythroid 24%EC was sprayed once at 1 kg

ai/ha to a silt loam soil (1-2%OM, pH 6.0). Soil cores of 0-6" and 6-12" were collected on days 0, 31, 70, and 135. For the 0-6" soil cores, the reviewer reported a DT50 of << 31 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 0.93 mg/kg immediately post-application (day 0) to 0.06 mg/kg on day 31. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, the degradate 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid declined from a maximum of 0.04 mg/kg on day 31 to < 0.01 mg/kg on day 135. The degradate 4-fluoro-3-phenoxybenzoic acid was not detected above a detection limit of 0.01 mg/kg in the 0-6" cores.

All analyte detections in the 6-12" cores were < 0.05 mg/kg. The site received 2.0 inches of precipitation during the first 30 days post-application.

9-2-5) Stilwell KS: Cyfluthrin in the form of Baythroid 24% EC was sprayed once at 1 kg ai/ha to a sandy loam soil (3-4%OM, pH 6.0). Soil cores of 0-6" and 6-12" were collected on days 0, 31, 62, and 123. For the 0-6" soil cores, the reviewer reported a DT50 of << 31 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 0.51 mg/kg immediately post-application (day 0) to 0.05 mg/kg on day 31. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, neither degradate was detected above a detection limit of 0.01 mg/kg.

All analyte detections in the 6-12" cores were < 0.07 mg/kg. The site received 4.2 inches of precipitation during the first 30 days post-application.

9-2-6) Tifton GA: Cyfluthrin in the form of Baythroid 24%EC was sprayed once at 1 kg ai/ha to a loamy sand soil (0.9%OM, pH 6.5). Soil cores of 0-6" and 6-12" were collected on days 0, 31, 62, and 124. For the 0-6" soil cores, the reviewer reported a DT50 of << 31 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 0.52 mg/kg immediately post-application (day 0) to < 0.01 mg/kg on day 31. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, the degradate 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid declined from a maximum of 0.05 mg/kg on day 31 to < 0.01 mg/kg on day 62. The degradate 4-fluoro-3-phenoxybenzoic acid was not

detected above a detection limit of 0.01 mg/kg in the 0-6 " cores.

All analyte detections in the 6-12" cores were < 0.02 mg/kg. The site received 6.2 inches of precipitation during the first 30 days post-application.

9-2-7) Vero Beach FL: Cyfluthrin in the form of Baythroid 24%EC was sprayed once at 1 kg ai/ha to a loamy sand soil (<1%OM, pH > 7.5). Soil cores of 0-6" and 6-12" were collected on days 0, 31, 62, and 122. For the 0-6" soil cores, the reviewer reported a DT50 of << 31 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 0.44 mg/kg immediately post-application (day 0) to < 0.01 mg/kg on day 31. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, detections of both degradates were < 0.02 mg/kg.

None of the analytes were detected above a detection limit of 0.01 mg/kg in the 6-12" cores. The site received 6.3 inches of precipitation during the first 30 days post-application.

9-2-8) Belle Grade FL: Cyfluthrin in the form of Baythroid 24%EC was sprayed once at 1 kg ai/ha to a peat soil (52.8%OM, pH 5.7). Soil cores of 0-6" and 6-12" were collected on days 0, 32, 62, and 120. For the 0-6" soil cores, the reviewer reported a DT50 of << 32 days. For the 0-6" soil cores, cyfluthrin was reported to decline from 1.86 mg/kg immediately post-application (day 0) to < 0.42 mg/kg on day 32. The sampling intervals were inadequate to compute a regression based half-life.

In addition to analyzing for cyfluthrin, analyses were also performed for potential degradates 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid and 4-fluoro-3-phenoxybenzoic acid. In the 0-6" soil cores, the degradate 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid declined from a maximum of 0.04 mg/kg on day 32 to < 0.01 mg/kg on day 60. All detections of the degradate 4-fluoro-3-phenoxybenzoic acid in the 0-6 " cores were < 0.02 mg/kg.

All analyte detections in the 6-12" cores were < 0.13 mg/kg. The site received 4.9 inches of precipitation during the first 30 days post-application.

9-3) Cypermethrin:

9-3-1) Madera CA: Cypermethrin in the form of Ammo 2.5 EC was applied three times at 0.2 lb ai/acre/application to a bare silt loam soil (2-4% clay, 0.2-0.6% OM, pH 6.5-7.2). Total rainfall and irrigation combined were 0.68 inches 0-13 days after the last application,

and 0.77 inches 14-26 days after the last application. Total rainfall and irrigation combined during the study was 16.5 inches.

Soil cores of depths 0-3, 3-6, 6-12, 12-18, 18-24, 24-30, and 30-36 inches were collected immediately after each of the 3 applications, and 2, 4, 7, 14, 21, 28, 60, 90, 120, 150, and 180 days after the last (3rd) application. The soil cores were analyzed for cypermethrin and potential degradates cis-DCVA, trans-DCVA, and 3-phenoxybenzoic acid.

Based upon dissipation in the top 0-3" soil cores, EFED computed a half-life of 12.2 days ($r^2 = 0.704$, $n = 7$) over the 28 days required for the chemical to dissipate to a level below the detection limit.

Immediate post-application concentrations of cypermethrin in 0-3" cores were 77, 134, and 215 ug/kg. After the third application, cypermethrin declined from 215 ug/kg on day 0 to 145 ug/kg (day 2), 112 ug/kg (day 4), 46 ug/kg (day 7), 46 ug/kg (day 14), 56 ug/kg (day 21), 31 ug/kg (day 28) to < its detection limit of 7 ug/kg (days 60, 90, 120, 150, and 180). Cypermethrin was detected in 3-6" cores collected immediately after each application (18, 8, and 33 ug/kg), and the following days after the 3rd application: day 2 (20 ug/kg) and day 4 (29 ug/kg). Cypermethrin was detected at 10 ug/kg in one 6-12" core collected 2 days after the last application.

Cypermethrin was not detected above a detection limit of 7 ug/kg in any soil cores collected below 6 inches.

The degrade 3-phenoxybenzoic acid was detected in 0-3" cores collected immediately after the 2nd application (8 ug/kg), immediately after the third application (17 ug/kg), and the following days after the 3rd application: day 2 (25 ug/kg), day 4 (32 ug/kg), day 7 (25 ug/kg), day 14 (24 ug/kg), day 21 (8 ug/kg), and day 28 (7 ug/kg). It was not detected above a detection limit of 7 ug/kg in any soil cores collected 3 inches.

Potential degradates cis- and trans-DCVA were not detected above a detection limit of 7 ug/kg in any of the soil cores.

9-3-2) Cheneyville LA: Cypermethrin in the form of Ammo 2.5 EC was applied three times at 0.2 lb ai/acre/application to a bare loamy sand soil (6% clay, 0.7% OM, pH 7.0). Total rainfall and irrigation were 4.4 inches 0-7 days after the last application, and 1.45 inches 8-14 days after the last application. Total rainfall and irrigation during the study was 53.7 inches.

Soil cores of depths 0-3, 3-6, 6-12, 12-18, 18-24, 24-30, and 30-36 inches were collected immediately after each of the 3 applications, and 2, 4, 7, 14, 21, 28, 60, 90, 120, 150 days after the last (3rd) application. The soil cores were analyzed for cypermethrin and potential degradates cis-DCVA, trans-DCVA, and 3-phenoxybenzoic acid.

Based upon dissipation in the top 0-3" soil cores, EFED computed a half-life of 3.2 days ($r^2 = 0.880$, $n = 6$) over the 28 days required for the chemical to dissipate to a level below the detection limit.

Immediate post-application concentrations of cypermethrin in 0-3" cores were 148, 187, and 301 ug/kg. After the third application, cypermethrin declined from 301 ug/kg (day 0) to 231 ug/kg (day 2), 29 ug/kg (day 7), 17 ug/kg (day 14), 16 ug/kg (day 21), 7 ug/kg (day 28) to < its detection limit of 7 ug/kg (days 60, 90, 120, and 150). < its detection limit of 7 ug/kg by 60 days post-application. Cypermethrin was not detected above a detection limit of 7 ug/kg in any cores collected below 3 inches.

The degradate trans-DCVA was detected in 0-3" cores collected on the following days after the 3rd application: day 2 (16 ug/kg) and day 7 (8 ug/kg). The degradate 3-phenoxybenzoic acid was detected in 0-3" cores collected immediately after the 2nd application (10 ug/kg), immediately after the 3rd application (20 ug/L), and 2 days after the 3rd application (44 ug/kg). The degradate cis-DCVA was not detected above a detection limit of 7 ug/kg in any of the soil cores.

None of the analytes were detected above a detection limit of 7 ug/kg in any of the soil cores collected below 3 inches.

9-4) Deltamethrin:

9-4-1) Poterville CA: Deltamethrin in the form of the DECIS EC 25 formulation was ground spray applied nine times at 0.02 lb ai/acre/application and a tenth time at 0.04 lbs ai/acre to both bare ground and cotton cropped plots. The study was conducted on a loamy sand whose average characteristics in the top 0-6" were 1.04% OM, pH 6.8, and 8% clay. During the August-October application period, rainfall and irrigation combined were 14 inches in August, 8.1 inches in September, and 2.5 inches in October. Rainfall and irrigation combined were 17.9 inches for November through May.

Soil cores of depths 0-6, 6-12, 12-18, and 18-24 inches were collected immediately post-application after each of the ten applications and 1, 3, 7, 14, 30, 60, 90, 120, 150, 180, and 210 days after the last application. Analyses were performed for the parent cis-deltamethrin as well as potential transformation products trans-deltamethrin and 3-(2,2-dibromoethenyl)--2,2-dimethylcyclopropane carboxylic acid hereafter referred to as Br₂CA. It was not specified whether analyses were just done for the cis-Br₂CA or for the both cis- and trans- isomers.

Based upon dissipation in the top 0-6" of soil in the bare ground plots after the last application, EFED calculated a half-life of 60.8 days ($r^2 = 0.492$, $n = 9$) over the entire interval 0 to 120 days post-application for the parent cis-deltamethrin. However, the dissipation curve does appear to be somewhat biphasic. EFED calculated a 1st phase

half-life of 5.7 days (0.938 , $n = 4$) over the interval 0 to 7 days post-application and a second phase half-life of 103 days ($r^2 = 0.246$, $n = 6$) over the interval 7 to 120 days.

Immediate post-application concentrations of cis-deltamethrin in 0-6" bare plot cores ranged from 4 ug/kg to 43 ug/kg. Cis-deltamethrin concentrations in the 0-6" cores collected after the last application declined from 17 ug/kg at day 0 and 19 ug/kg at day 1 to 13 ug/kg (day 3), 8 ug/kg (day 7), 12 ug/kg (day 14), 5 ug/kg (days 30 and 60), 2 ug/kg (day 90), 7 ug/kg (day 120) and to < then the DL of 2 ug/kg (days 150, 180, 210). Cis-deltamethrin was detected in 6-12" bare plot cores collected immediately after the 7th application (3 and 3 ug/kg), immediately after the 10th application (3, 11, and 17 ug/kg) and the following days after the 10th application: day 1 (8, 8, and 11 ug/kg), day 3 (4, 6, and 19 ug/kg), day 7 (3, 4, and 5 ug/kg), and day 30 (5 ug/kg).

The degradate (Br_2CA) was detected at concentration of 8 ug/kg in one 0-6" bare plot core collected 3 days after the last application. It was detected in 6-12" bare plot cores collected immediately after the 10 application (4 ug/kg), and the following days after the 10th application: day 1 (4 and 5 ug/kg), day 3 (5 and 10 ug/kg), and day 120 (5, 5, and 6 ug/kg).

The potential degradate trans-deltamethrin was not detected above a detection limit of 0.002 mg/kg in any of the bare ground soil cores.

None of the analytes were detected in soil cores taken below 12 inches.

9-4-2) Hollandale MN: Deltamethrin in the form of the DECIS EC 25 formulation was ground spray applied 9 times at 0.04 lb ai/acre/application and a tenth time at 0.1 ai/acre to both bare ground and corn cropped plots. The study was conducted on a loamy sand whose average characteristics in the top 0-6" were 2.17%OM, pH 5.6, and 9.2% clay. Rainfall and irrigation combined exceeded the 10 year average from May through August, but was below the 10 year average for September, October, and November.

Soil cores of depths 0-15, 15-30, 30-45, 45-60, 60-75, and 75-90 cm were collected immediately post-application after each of the ten applications and 1, 3, 7, 14, 28, 60, 90, and 118 days after the last application. Analyses were performed for the parent cis- α S-deltamethrin as well as potential transformation products trans- α S-deltamethrin, cis- α R-deltamethrin and 3-(2,2-dibromoethenyl)--2,2-dimethylcyclopropane carboxylic acid hereafter referred to as Br_2CA . It was not specified whether analyses were just done for the Cis- Br_2CA or for the both cis- and trans isomers.

Based upon dissipation in the top 0-15 cm of soil in the bare ground plots after the last application, EFED calculated a half-life of 63.6 days ($r^2 = 0.563$, $n = 9$) for the parent cis-deltamethrin over the entire interval 0 to 118 days post-application .

Immediate post-application concentrations of cis-deltamethrin in 0-15 cm bare plot cores ranged from 11 ug/kg to 41 ug/kg and averaged 19 ug/kg. Cis-deltamethrin concentrations in the 0-6" cores collected after the last application were 41 ug/kg (day 0), 16 ug/kg (day 1), 26 ug/kg (day 3), 28 ug/kg (day 7), 11 ug/kg (day 14), 15 ug/kg (day 28), 8 ug/kg (day 60), 6 ug/kg (day 90), and 10 ug/kg (day 118). Cis-deltamethrin was detected in 15-30 cm bare plot cores collected immediately after the 10th application (4 ug/kg) and the following days after the 10th application: day 1 (4 ug/kg), day 3 (6 ug/kg), day 7 (2 ug/kg), and day 14 (3 ug/kg). Cis-deltamethrin was detected in 30-45 cm bare plot cores collected immediately after the 10th application (3 ug/kg) and the following days after the 10th application: day 1 (3 ug/kg), day 3 (2 ug/kg), and day 7 (2 ug/kg). Cis-deltamethrin was detected at 3 ug/kg in one 45-60 cm bare plot core collected 7 days after the 10th application. It was below its quantification limit of 2 ug/kg in all bare plot cores deeper than 60 cm.

The cis-R-deltamethrin isomer was detected at 2 ug/kg in one 0-15 cm bare plot core collected 1 day after the 10th application, but it was below its quantification limit of 2 ug/kg in all other bare plot cores. The trans-deltamethrin isomers and Br₂CA were below their quantification limits of 2 ug/kg in all of the bare plot cores.

9-4-3) Rosa LA: Deltamethrin in the form of the DECIS FLO 50 formulation was ground spray applied 9 times at 0.04 lb ai/acre/application and a tenth time at 0.1 ai/acre to both bare ground and cotton cropped plots. The study was conducted on a loam whose average characteristics in the top 0-6" were 0.7%OM, pH 6.6, and 24% clay. Rainfall and irrigation combined appeared to be comparable to 10 year monthly averages throughout the study.

Soil cores of depths 0-15, 15-30, 30-45, 45-60, 60-75, and 75-90 cm were collected immediately post-application after each of the ten applications and 1, 3, 7, 14, 30, 60, 91, 121 and 150 days after the last application. Analyses were performed for the parent cis- α S-deltamethrin as well as potential transformation products trans- α S-deltamethrin, cis- α R-deltamethrin and 3-(2,2-dibromoethenyl)--2,2-dimethylcyclopropane carboxylic acid hereafter referred to as Br₂CA. It was not specified whether analyses were just done for the Cis-Br₂CA or for the both cis- and trans isomers.

Based upon dissipation in the top 0-15 cm of soil in the bare ground plots after the last application, EFED calculated a half-life of 209 days ($r^2 = 0.280$, $n = 10$) for the parent cis-deltamethrin over the entire interval 0 to 150 days post-application.

Immediate post-application concentrations of cis-deltamethrin in 0-15 cm bare plot cores ranged from 7 ug/kg to 48 ug/kg, and averaged 19 ug/kg. Cis-deltamethrin concentrations in the 0-6" cores collected after the last application were 18 ug/kg (day 0), 17 ug/kg (day 1), 24 ug/kg (day 3), 21 ug/kg (day 7), 25 ug/kg (day 14), 10 ug/kg (day 30), 15 ug/kg (day 60), 9 ug/kg (day 91), and 13 ug/kg (day 121). It was detected at 4 ug/kg in one 15-30 cm core collected immediately after the first application. It was below its 2 ug/kg level of

quantification in all other bare plot cores.

The cis-R-deltamethrin isomer was detected in 0-15 cm bare plot cores collected immediately after the 6th application (4 ug/kg), 8th application (2 ug/kg), the 9th application (3 ug/kg), and 10 application (2 ug/kg) as well as the 121st day after the 10th application (2 ug/kg). It was below its quantification limit of 2 ug/kg in all other cores.

The trans-deltamethrin isomers and Br₂CA were below their quantification limits of 2 ug/kg and 10 ug/kg, respectively, in all of the cores.

9-5) Fenpropathrin:

9-5-1 Fresno, California: Fenpropathrin, in the form of Danitol EC, was applied four times at 0.4 lb ai/A/application (10 day intervals) to a bare sandy loam soil (7-17% clay, 0.3-0.7% OM, pH 6.5-7.8). Irrigation totalled 4.02 inches during application, and 54.09 inches in the period from the last application to day 365 postapplication.

Four to five cores were sampled at each test interval to a depth of 90 cm. The soil cores were divided in segments (0-15, 15-30, 30-45, 45-60, 60-75, and 75-90 cm. Sampling was performed immediately after each application and on days 1, 3, 7, 14, 21, and 28, and on months 2, 3, 4, 6, 8, 10, 12.

For the 0-15 cm soil layer, the registrant reported a calculated half-life of 17 days (correlation coefficient -0.94199, n=8).

The soil cores were analyzed for fenpropathrin and potential degradates CONH₂-fenpropathrin, 4'-OH-fenpropathrin and desphenylfenpropathrin. In the 0-15 cm soil depth, fenpropathrin was 0.06-0.14 ppm 1 day following the first treatment, 0.18-0.35 ppm immediately after the fourth treatment, and 0.02-0.07 ppm at 21-28 days. In the deeper soil depths, fenpropathrin was ≤0.01 ppm at all sampling intervals.

The degradate CONH₂-fenpropathrin was ≤0.04 ppm in the upper 14 cm after the second through fourth applications, 0.03-0.09 ppm at 1-7 days posttreatment, and 0.01-0.06 ppm at 14-21 days. This degradate was not detected in deeper soil depths.

The degradates desphenylfenpropathrin and 4'-OH-fenpropathrin were not detected (≤0.01 ppm) at any soil depths (except for one sample that had 0.01 ppm of 4'-OH-fenpropathrin on day 61 posttreatment).

9-5-2) Greenville, Mississippi: Fenpropathrin, in the form of Danitol E.C., was applied four times at 0.4 lb a.i./A/application (weekly intervals) to a loam soil (10.2% clay, 0.41% OM, pH 6.3), cropped with cotton. Rainfall plus irrigation totaled 5.7 inches during the treatments, 22.54 inch between days 1 and 94 after the last treatment, and 51.53 inches

from 95-365 days after the last treatment.

Four to five cores were sampled at each test interval to a depth of 90 cm. The soil cores were divided into 0-7.5, 7.5-15, 15-30, 30-45, 45-60, 60-75, and 75-90 cm segments. For the 0-15 cm soil cores, a registrant-calculated half-life of 95 days was reported (correlation coefficient -0.73526).

The soil cores were analyzed for parent fenpropathrin and potential degradates CONH₂-fenpropathrin, 4'-OH-fenpropathrin and desphenylfenpropathrin.

In the 0 to 7.5 cm soil depth, fenpropathrin was 0.10-0.17 ppm immediately after the first treatment, 0.30-0.60 ppm after the second treatment, 0.32-0.82 ppm after the third treatment, and 0.13-0.70 ppm after the fourth treatment. Following the fourth application, fenpropathrin was 0.41-1.52 ppm at day 1 posttreatment, 0.32-2.59 ppm at 21-28 days, and 0.02-0.14 ppm at 119-300 days.

In the 0 to 7.5 cm soil depth, the degradate CONH₂-fenpropathrin was not detected until after the fourth treatment, when it was 0.02-0.09 ppm at day 7, 0.02-0.05 at 14-21 days, 0.01-0.11 ppm at 28 days and ≤ 0.04 ppm thereafter.

The degradate desphenylfenpropathrin was ≤ 0.03 ppm at 1-61 days following the fourth treatment (maximum on day 28). The degradate 4'-OH-fenpropathrin was ≤ 0.03 ppm at 28 days following the fourth treatment and was not detected at other sampling intervals.

9-5-3) Teiton, Washington Fenpropathrin (in the form of Danitol 2.4 EC) dissipated with a registrant-calculated half-life of 144 days in the 0- to 7.5-cm depth of an apple orchard planted on loam/silt loam soil in Teiton, Washington, following the last of eight treatments (0.4 lb a.i./A/application at 14 days intervals) with fenpropathrin. Average fenpropathrin in the 0- to 7.5-cm depth interval increased from <0.01 ppm (LOD) prior to treatment to a maximum of 0.34 ppm during the eight applications and it decreases to 0.02-0.03 ppm by 364 days after the last treatment.

Fenpropathrin residues remained in the upper 0-7.5 cm soil layer (with only one exception). Data were highly variable probably due to the method of application (air blast sprayer, application to foliage).

The degradate desphenylfenpropathrin was not detected (<0.01 ppm) at any depth at any sampling interval.

During the application period, less than 1 inch of precipitation fell, irrigation totalled 20.74 inches.

9-5-4) Phelps, New York Fenpropathrin, in the form of Danitol 2.4 EC, dissipated with an

estimated half-life of 8 days ($r=-0.91$; $n=5$) in the 0-7.5 cm surface layer, after eight weekly applications at 0.4 lb a.i./A. The top soil was a loam (14-18% clay, 1.9-2.7% O.M., pH 5.0-5.9; one of the plots had a soil texture of sandy loam) planted to apples in Phelps, New York.

Five cores were taken on the day before treatment, immediately after each treatment, and on days 1, 3, 7, 14, 21, 28, 63, 93, 182, and 273 after the last treatment. The soil cores were divided in segments corresponding to depths of 0-7.5, 7.5-15, 15-22.5, 22.5-30, 30-45, 45-60, 60-75, 75-90 cm,

Fenpropathrin was <0.01 ppm before the first application, 0.02-0.28 ppm from the first to the fourth application, <0.01 -0.09 from the fifth to the eight applications, 0.03-0.07 ppm 3 days after the last application, and 0.01-0.02 ppm on day 14 after the last application.

Fenpropathrin remained mainly in the upper 0-7.5 cm soil layer, except for detections at 0.02-0.05 ppm in the 7.5-15 cm soil layer immediately after the second and third applications.

The metabolite desphenylfenpropathrin was <0.01 ppm (LOD) at all sampling intervals in all soil depths tested.

9-5-5) Fresno, California Fenpropathrin, in the form of Danitol 2.4 EC, dissipated with an estimated half-life of 14 days ($r=-0.949$, $n=6$) in the 0-7.5 cm surface layer after four applications at 0.2 lb a.i./A. The top soil was a loam (12-16% clay, 0.3-0.9% O.M., pH=7.6-8.4), planted to grapes in Fresno, California.

Five cores were taken on the day before treatment, immediately after each treatment and on days 1, 3, 7, 14, 21, 28, 42 and months 2, 3, 6, 9, 12, 15 and 18 after the fourth treatment. The soil cores were divided in segments corresponding to a depth of 0-7.5, 7.5-15, 15-22.5, 22.5-30, 30-45, 45-60, 60-75 and 75-90 cm.

In the top 0-7.5 cm soil fenpropathrin was <0.01 ppm on the day before treatment, 0.01-0.07 ppm after each of the four applications, <0.01 -0.08 ppm from day 1 to day 28 after treatment, and <0.011 from day 28-56 after treatment. Fenpropathrin remained in the top 0-7.5 cm soil layer. The degradate desphenylfenpropathrin was not observed in any of the test intervals and in any of the soil depths.

9-6) Esfenvalerate:

9-6-1) Madera, California: Esfenvalerate, in the form of Asana (1.9 EC), at 0.5 lb a.i./A, dissipated from a sandy loam in Madera, California (16% clay, 0.8% O.M., pH 8.2), with a registrant-calculated half-life of 14 days ($r^2=0.94$, calculated with data through day 30). In the top 0-15 cm (ca. 6 inches) total esfenvalerate residues in the soil were 0.15 ppm

immediately after application, 0.08 ppm at 7 days after application, 0.05 ppm at 14 days and <0.01 ppm (limit of detection) 90 days after application. It appears that esfenvalerate has little or no potential to leach into lower depths, despite a considerable amount of water was added by irrigation beginning 9 days after application (approximately 5-10 inches of water applied during the initial 60 days posttreatment).

9-7) Cyhalothrin:

9-7-1) North Carolina, California, Mississippi, and Illinois: Cyhalothrin, in the form of Karate (1 lb/gal EC), applied at 1.0 lb a.i./A, dissipated with a half-life of 14-28 days in sandy loam soils in North Carolina (Goldsboro, 4% clay, 2.0 % O.M., pH 7.6) and California (Visalia, 11% clay, 0.8% O.M., pH 7.6), and 28-60 days in silt loam soil in Mississippi (Vicksburg, 14% clay, 1.2% O.M., pH 7.0) and silty clay loam soil in Illinois (Champaign, 32% clay, 3.9% O.M., pH 7.9).

Cyhalothrin was ≤ 0.01 ppm in the 6-12 inch soil depth at all sites at all sampling intervals, indicating little leaching.

R157836, the opposite enantiomer pair formed by epimerization was ≤ 0.03 ppm in the 0-6 inch soil depth and was not detected (<0.01 ppm) in the 6-12 inch soil depth at all sites.

Samples were collected at regular intervals up to 188 days posttreatment.

9-7-2) Mississippi and Illinois: [^{14}C]-Cyhalothrin (cyclopropane and phenyl labeled), at 142-146 g a.i./ha, dissipated from the upper 10 cm of silt loam (MS, 13% clay, 0.9% O.M., pH 5.5) and clay loam (IL, 30% clay, 3.8% O.M., pH 6.4) with half-lives of 12 and 33 days, respectively. The studies were conducted in plastic cylinders in Vicksburg, Mississippi and Champaign, Illinois. Soil samples (the entire cylinders) were taken immediately after treatment and at regular intervals up to 115 days (MS) and 279 days (IL). Approximately 27 inches of rain fell in the Illinois site, and 12 inches in the Mississippi site during the test period.

In Vicksburg, MS, cyhalothrin comprised 83.2-85.6% of the applied immediately after treatment, 22.2-26.4% at 14 days after treatment, and 2.5-2.7 at 57 days after treatment.

In Champaign, IL, cyhalothrin was 98.8% of the applied immediately after treatment, 49.8-55.5% at 28 days after treatment, 20.1-38.5% after 56 days after treatment, and 17.8-20.9% after 279 days.

[^{14}C]-Cyhalothrin residues did not appear to leach substantially to the subsoils.

9-8) Tefluthrin:

9-8-1) Vicksburg MS:

In this supplemental study, tefluthrin (1.5% G) was applied to two field plots of silt loam soil, at 0.695 lb ai/A. Soil samples were taken immediately posttreatment and at regular intervals through 215 days posttreatment. Even though sampling was insufficient to clearly assess the rate of dissipation, results obtained for both plots indicate that residues of tefluthrin persist through 215 days in plot 1 (0.066 ppm) and 185 days in plot 2 (0.036 ppm), that is, the last test interval in both cases. Tefluthrin was not detected below the 0-10 cm soil layer in any test interval (detection limit 0.005 ppm).

9-8-2) Goldsboro NC, Champaign IL, and White Heath IL:

Tefluthrin (10.3% EC and 1.5% G), at 2 lb ai/A, dissipated from the upper 6 inches of a sandy loam (NC), silt loam (IL), and silty clay loam (IL) with half-lives ranging from 28 to 124 days. At all sites, tefluthrin decreased to ≤ 0.21 ppm by one year posttreatment. Tefluthrin was ≤ 0.02 ppm in the 6- to 12- inch soil depth. There was a high degree of variation in the values of individual soil samples. Degradates were not monitored in this study.

9-8-3) Vicksburg MS, and Champaign IL:

[¹⁴C]-Tefluthrin (cyclopropane- and phenyl- labeled), in the form of 1.5% G, at 0.68 lb ai/A, dissipated from the upper 5 cm of the soil with half-lives of 14-30 days at the Vicksburg, MS site (silt soil) and 56-92 days at the Champaign, IL site (silty clay loam soil). After 321 days at the IL site, 35% of the parent remained undegraded. After 281 days at the MS site, parent tefluthrin was not detected.

Tefluthrin total residues dissipated from the upper 5 cm of the soil with half-lives of 30-57 days at the Vicksburg, MS site, and 92-124 days at the Champaign, IL site.

9-9) Tralomethrin: In a supplemental study tralomethrin (Treflan) at 15 or 30 g ai/A was applied seven times at one week intervals. No residues were found above the detection limit (20 ppb) in the top 10 inches of a silt loam soil (6% clay, >1% OM, pH unspecified) planted to cotton five weeks after the last application.

9-10 Permethrin: Permethrin at 0.4 lb ai/A (terrestrial food use maximum rate) appeared to dissipate in the field with half-lives of 17 (North Carolina) and 43 (Illinois) days on bare-ground plots using five applications of Pounce 3.2 EC at 0.4 lb ai/A per application (ground sprayer). No pattern of leaching was observed for parent and permethrin's 2 principal soil metabolites trans-DCVA and 3-phenoxybenzoic acid.

Property	Bifenthrin	Cyfluthrin	Cypermethrin	Deltamethrin	Fenpropathrin	Fenvalerate	Cyhalothrin	Tefluthrin	Tralomethrin	Permethrin
solubility (ppm)	1.0x10 ⁻⁴	1.2x10 ⁻³	0.20	2.0x10 ⁻⁴	1.4x10 ⁻²	2.0x10 ⁻³	4.0x10 ⁻³	2.0x10 ⁻²	7.1x10 ⁻³	0.07
vapor pressure (mm Hg)	1.8x10 ⁻⁷	3.3x10 ⁻⁸	6.7x10 ⁻⁹	1.5x10 ⁻⁸	5.48x10 ⁻⁶	1.1x10 ⁻⁸	2.0x10 ⁻¹⁰	5.5x10 ⁻⁵	1.3x10 ⁻¹³	2.15x10 ⁻⁸
Henry's Law const. Atm•m ³ /mol	5.6x10 ⁻⁴	1.6x10 ⁻⁵	1.6x10 ⁻⁸	5.0x10 ⁻⁵	1.80x10 ⁻⁴	6.08x10 ⁻⁸	2.96x10 ⁻⁸	1.6x10 ⁻⁵	1.6x10 ⁻¹¹	1.6x10 ⁻⁷
Hydrolysis pH 5	stable	stable	stable	stable	stable	stable	stable	stable	stable	stable
pH 7	stable	185 d.	stable	stable	stable	stable	stable	stable	stable	stable
pH 9	stable	1.9 d.	1.8 d.	2.5 d.	14.3-17.1 d.	stable	7 d.	>30 d.	stable	40-60 d.
Photolysis in water	stable	4.5 d.	36.2 d.	stable	stable	6 d.	~30 d.	>31 d.	1 hr.	80 d.
Photodegradation on soil	98.5-147 d.	5.3 d.	56.5 d.	9 d.	stable	stable	34 d.	> 31 d.	stable	>30 d.
Aerobic Soil Metabolism	129-250 d. three soils tested	74-95 d. two soils tested	60-61 d.	11-19 d. two soils tested	152 d.	75 d.	<30 d	<31 d.	39-82 d. three soils tested	37 d.
Anaerobic Soil Metabolism	stable	moderate (~30 d.)	52-63 d. 1 soil	31-36 d. 1 soil	186 d.	~1 yr. 3 soils	~30 days	> 30 days	≥96 d. 3 soils	204 d.
Mobility	immobile	immobile	immobile	immobile	immobile	immobile	immobile	immobile	immobile	immobile
# soils tested	4	6	4	6	5	4	4	4	4	5
Bioaccumulation edible	2110X	NA	161X	188X	200X	NA	NA	750X	6X	230X
(Non-edible) viscera	8720X	NA	833X	3640X	1400X	NA	7340X	1276X	920X	1000X
whole	6090X	854X	444X	698X	830X	503-3340X	2240X	2050X	490X	610X
Volatility										
Terrestrial Field Dissipation	192 d. 155 d. 228 d. 78-193 d. 126 d. 121 d.	<31 d. «32 d. «31 d. «31 d. «31 d. «32 d.	12 d. 3 d.	61 d. 5.7 d. 64 d. 209 d.	17 d. 95 d. 144 d. 8 d. 14 d.	14 d.	14-28 d. 12 d. 33 d.	stable 28-124 d. 56-92 d.	No residues observed 5 weeks after the last application	17 d. 43 d.